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APRIL 1978
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Popular Science MONTHLY®

The What's New magazine

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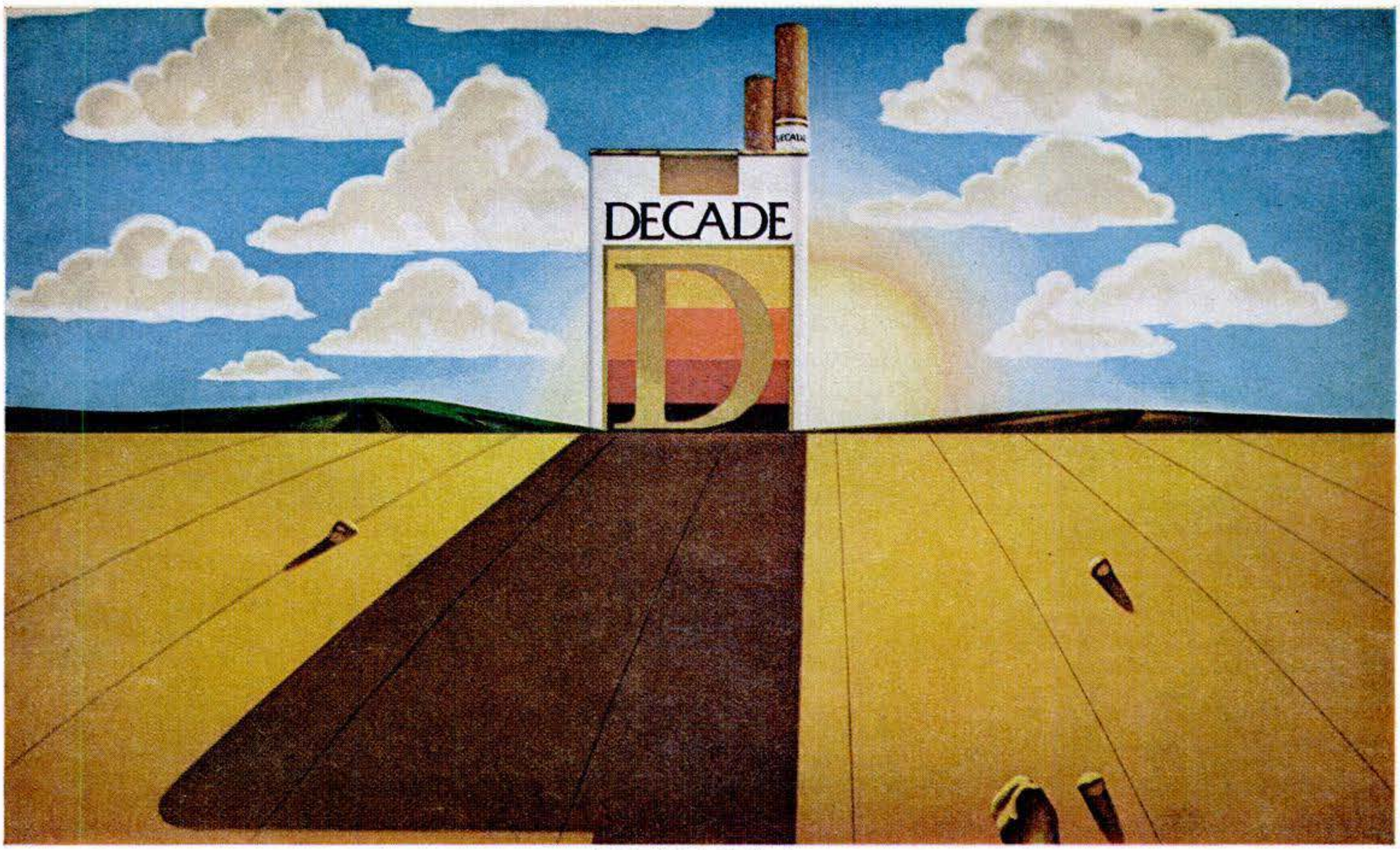

DECADE.
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This One

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How were we able to keep the taste in a low 'tar' when so many others have failed? Mainly by developing our unique "Total System" in which every part of a Decade cigarette is arranged in perfect balance with each other.

The tobacco, the filter, and even the paper.

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The Tobacco. "Flavor Packing"™ plus fifteen tobaccos boost taste.

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The Paper. High porosity paper controls burn rate.

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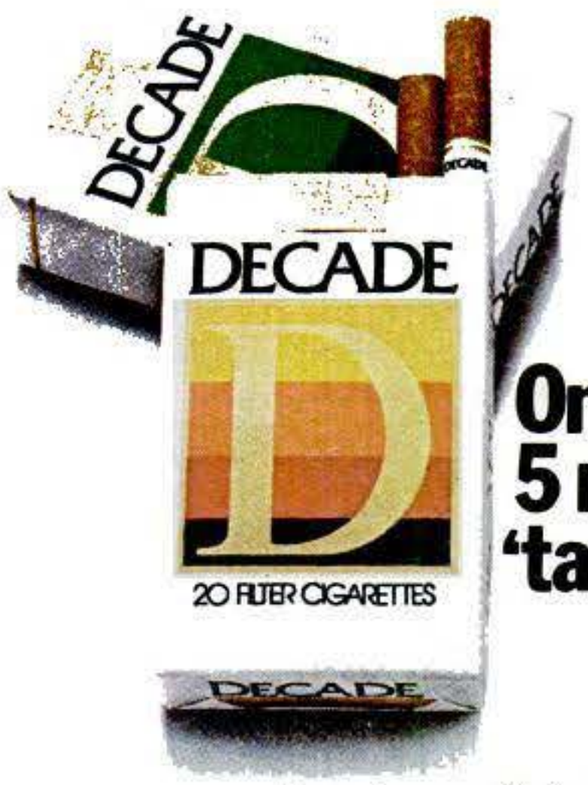

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PS READERS TALK BACK

Address letters for this column to: Readers Talk Back, 380 Madison Ave., New York, N.Y. 10017. Because of the large volume of mail, we are unable to acknowledge unpublished letters.

Rust rip-off

Re "Detroit's War on Corrosion" [Jan.], the rust problem is an expensive rip-off in this part of the country. The auto makers lie every year and tell us how much better their cars are. The dealers get rich with their rust-proofing, which at best is a joke.

I have a Chevy truck, and the paint started falling off the day I got it. I have spent over $600 trying to keep it looking as it should. The factory man says it is normal to repaint your new truck once a year. I'm supposed to believe this?

. . . I'm going to put a sign on my truck to protect me from any lawsuits. The sign will read, "Danger: This Chevy truck is self-destructing."

Ed Mifsud, Mayville, N.Y.

More on Shelter Institute houses

I read with interest the letter from Paul E. Vogel [RTB, Dec. '77] criticizing certain aspects of the Shelter Institute houses [PS, Sept. '77]. I would take issue with the last paragraph of his letter—about early [foundation] pole failures. While it is possible to have a failure in a 10-15 year period, the probability is extremely low if the user of the pressure-treated wood tells the producer how the product will be used.

The Forest Products Laboratory in Madison, Wis., publishes yearly test data on pressure-preserved wood, and these tests indicate a service life for wood treated with creosote, pentachlorophenol, and salt, in proper retention levels, in excess of 35-45 years. Average life of utility poles is in excess of 35 years.

C.A. Burdell,
Research and Environmental Director,
Southern Wood Piedmont Co.,
Spartanburg, S.C.

How to use split-core ammeters

In the article "How to Use Split-Core Ammeters" [Nov. '77], I believe you have misled your readers.

You imply that the power must be off when measuring current and that the voltage test leads can be connected while the jaws of the instrument are clamped around a conductor. One of the purposes of a clamp-on ammeter is to eliminate the need for turning off the power when measuring current as long as the jaws are clamped around an *insulated* conductor. Also, the instrument should be set up to measure only one function at a time; otherwise, erroneous readings can result.

We now have a ground adaptor available for use with the energizer that maintains the equipment's existing ground circuit while it is being used for current measurements.

Finally, the $39.50 price indicated for the Amprobe junior is incorrect; models with an ohmmeter range are $34.50.

Joe Perz, Advertising Manager,
Amprobe Instrument, Lynbrook, N.Y.

Evan Powell replies: "I wonder if an Amprobe could check our punctuation? The problem was caused by a misplaced period and semicolon. Instructions should read: 'When making current tests, slip the jaws over the conductor. Attach the leads to the terminals for voltage tests; then, while keeping hands off, turn the power on, note the reading, and turn power off again before removing the leads.'

"We advise readers to make voltage tests in this manner to eliminate any possibility of coming in contact with live conductors or terminals.

"The $39.50 price for the Amprobe model YTO 525100 shown was given to us by an Amprobe dealer. When we checked again after receiving Mr. Perz' letter, we were again told that it was $39.50."

Improve the opposed-piston diesel?

I read with great interest the article "Opposed-Piston Diesel" [Dec. '77]. I have an idea that I believe merits remitting to Donald Tryhorn of Armstrong Whitworth & Co., Ltd.

I would suggest the addition of two cylinders and pistons coaxially with

[*Continued on page 151*]

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Provides a true spatial image. Smooth 800-8000 Hz response for a "live" presence.

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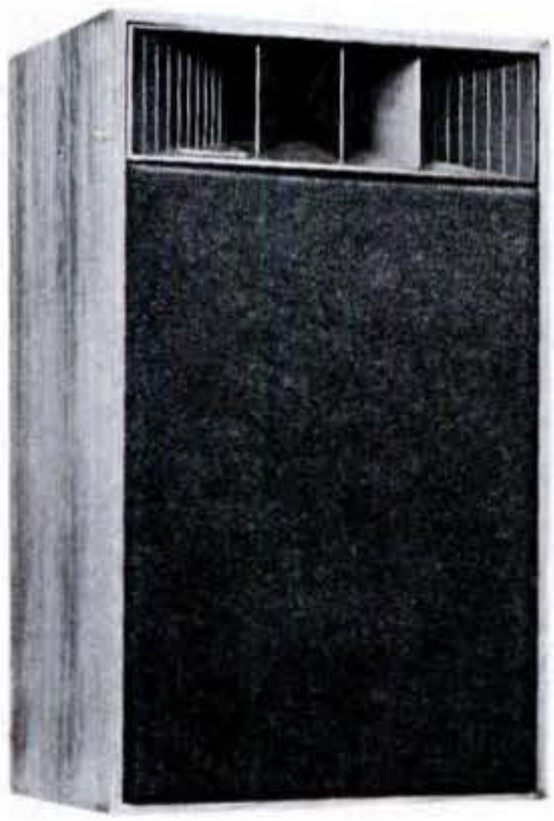
We make speaker positioning easy by including a cabinet with the look and feel of fine furniture — so the Mach One looks great anywhere!



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Massive 15″ woofer

The acoustic suspension, large-excursion cone has an effective radiating area of over 100 square inches—the equivalent of a huge air-pump — for bass you can feel all the way down to 20 Hz. The four-layer voice coil is wound on a brass form for heavy power handling capacity—over 100 watts peak program material.

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Hydraulic windmills smooth the changing winds

Two British-designed wind turbines use hydraulics to produce heat and electricity

By DAVID SCOTT

LONDON, ENGLAND

One drawback of wind power is its capricious nature. The changing winds demand costly automatic control systems to guarantee electrical generation at the rock-steady voltage and frequency needed for a TV set or motor-driven appliance, such as a turntable or washing machine.

Two British Don Quixotes are tilting independently at this prob-

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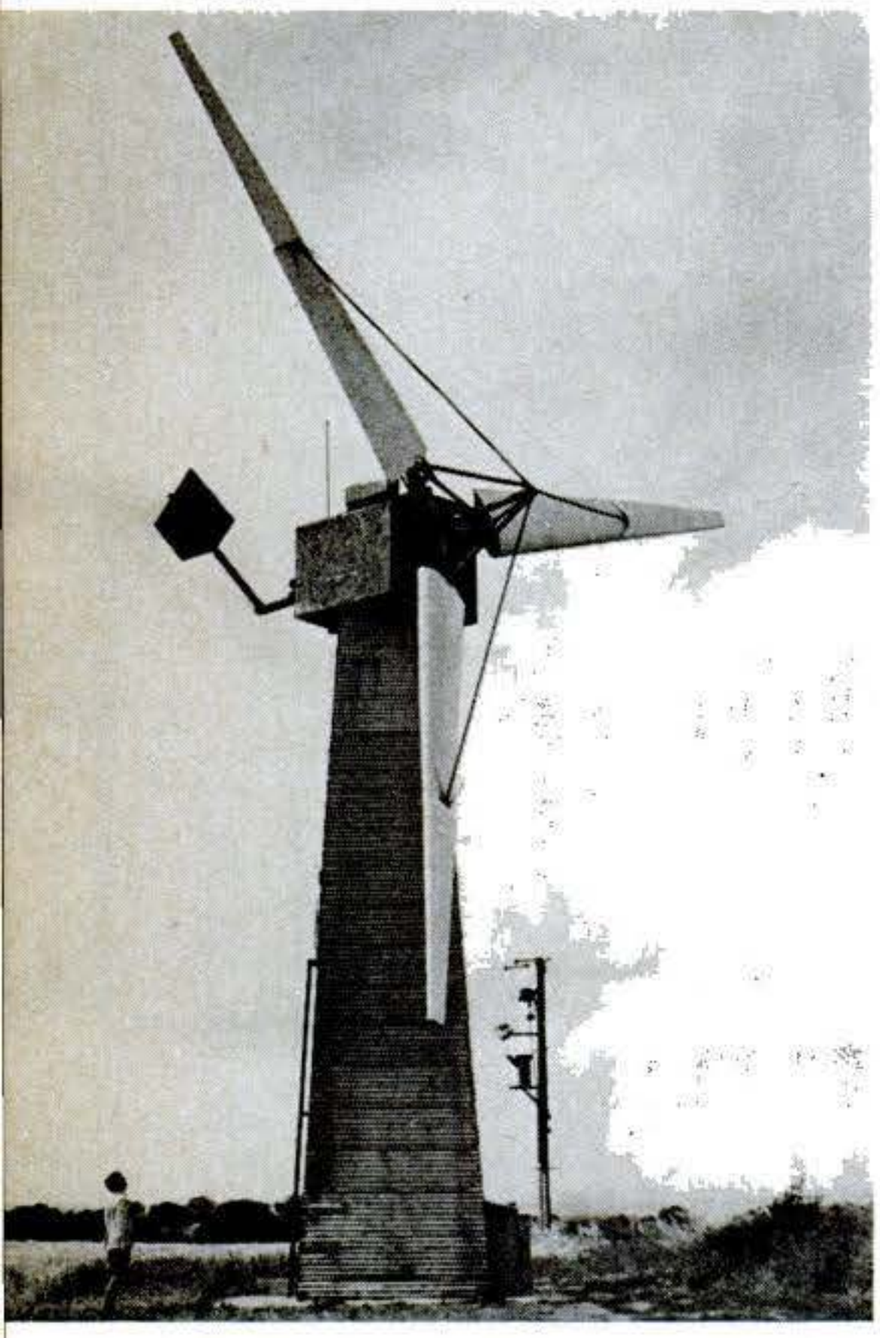
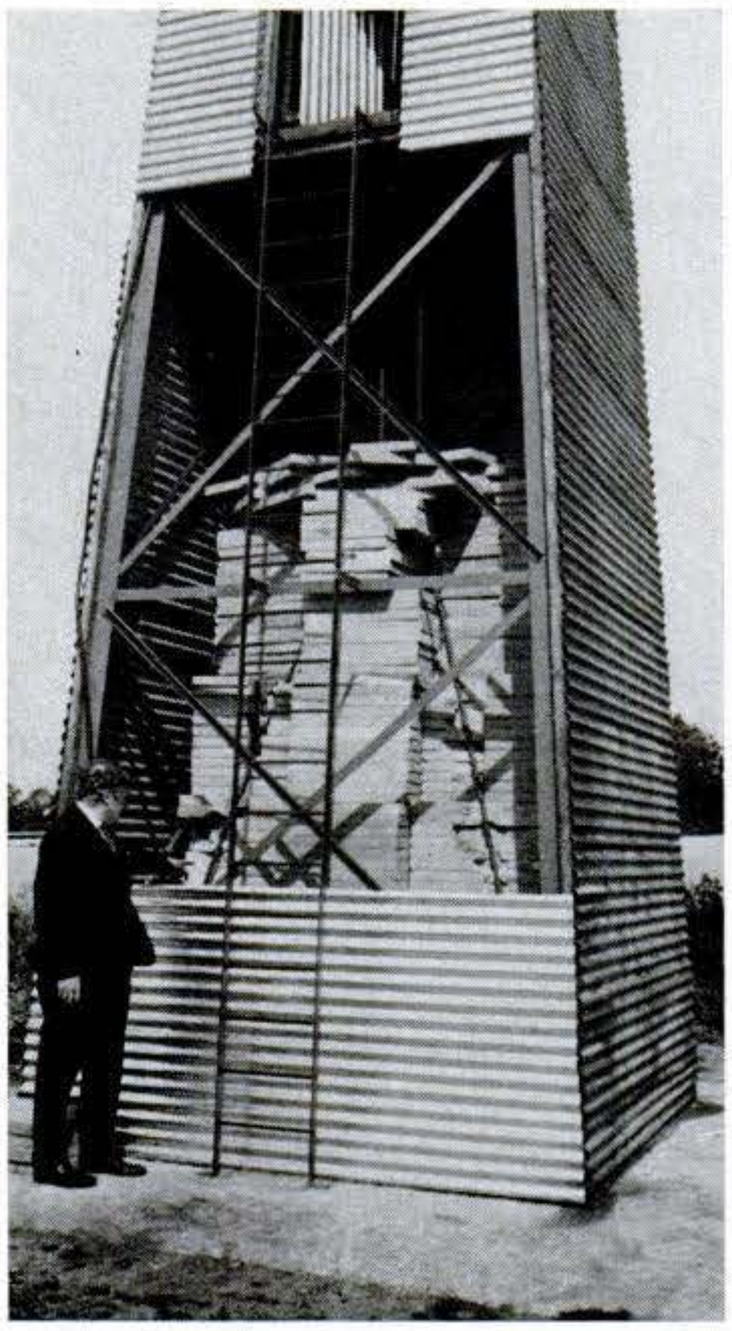
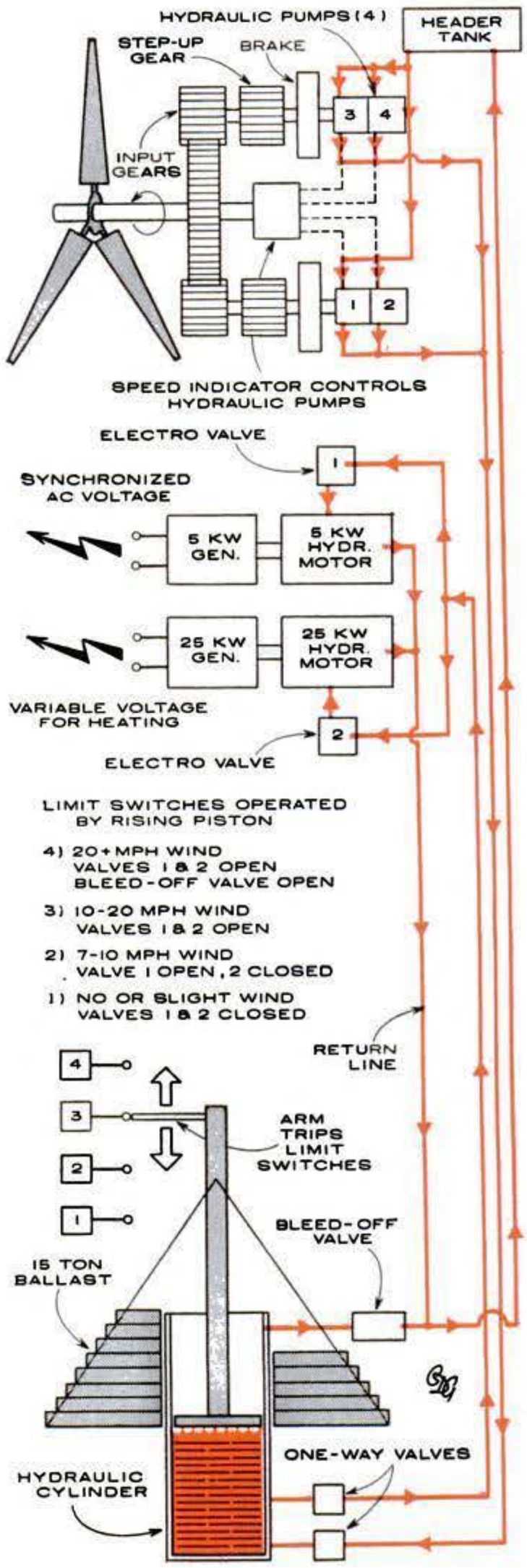




Three-blade, fixed-pitch rotor in Yorkshire drives four hydraulic pumps located at top of 45-foot tower (left). At right, designer points to stack of concrete blocks suspended from piston in hydraulic cylinder. Pressurized fluid from cylinder powers hydraulic motors that drive electric generators.



Four hydraulic pumps are continuously driven at same speed by Yorkshire mill, and hydraulic connections are in parallel (top of drawing at right). A speed-sensing regulator operates valves that add pumps in a cumulative sequence as wind increases, boosting fluid delivery. Output is fed into bottom of hydraulic cylinder, raising piston with suspended weight. Pressure from charged cylinder, held at a constant 2500 psi, drives one or both hydraulic motors, each coupled to a generator. Arm on piston rod trips a series of limit switches according to height. (Vertical travel is four feet.) Switches operate valves in high-pressure lines to the two motors, and cut them and their generators in as fluid volume in cylinder expands. In position shown, with a 10- to 20-mph wind, switch 3 has opened both valves so both motor-generators are running. When wind reaches 20 mph, pumps feed more oil to the cylinder than motors can absorb. Then arm rises to trip switch 4, opening bleed-off valve, which returns surplus oil to header tank. Above 35 mph an anemometer applies brakes to stop rotor.

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Thank goodness the best things never change.

Like the feeling you get every time you share the sounds and the smells of a misty morning.

Like the feeling you get every time you taste Smooth as Silk Kessler.

Consistently smooth. Sip after sip. Year after year. Money just can't buy a smoother whiskey.

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GARDEN STATE

6 separate brakes, shock absorbers even for the engine, a wax job your eyes may never see: inside the insides of the Mercedes-Benz 450SEL.

In the eyes of a Mercedes-Benz engineer, the examples of skill and care normally hidden from sight deep within the car are what most strongly stamp a 450SEL as a 450SEL and make it unique.

Herewith, that deep-down 450SEL story—an *engineer's-eye* view.

6,000 invisible welds

Observe that beneath its high-gloss enamel, the 450SEL body is a semi-monocoque or "unitized" structure—a steel hull in effect, studded with no fewer than 6,000 electric welds.

Between the time it first enters and finally leaves the paint shop, this body acquires 77 pounds' worth of protective coatings applied in 9 steps. Anti-corrosion wax is even sprayed into hollow recesses like the insides of the rocker panels before they are permanently sealed.

Almost 5 feet of hiproom

The 450SEL body shell is the largest Mercedes-Benz builds in volume production and the word for its interior space is ample. Yet this so-called "big" Mercedes is contained within an overall length of less than 18 feet—and at 73.6 inches of width is actually *slimmer* than a Nash Rambler compact of 28 years ago.

Linked to its own separate axle, each rear wheel of the 450SEL is freed to act on its own. Result: the left wheel can hit a bump or a dip without affecting the right, and vice versa. Each shock absorber has an upper chamber filled with oil and a lower chamber filled with pressurized *nitrogen* gas as a cushion against vibration.

Excessive vibration is good for neither a car nor its occupants. The engine's rubber-insulated mounts are augmented by two special hydraulic shock absorbers nestled on either side of the 450SEL's 4.5-liter V-8.

Examine the steering system and you will find yet *another* shock absorber, expressly meant to soak up thumps and bumps before they reach your hands on the wheel.

A black box that isn't there

The engineers eliminated pushrod-actuated valves and their adjustment (as well as their clatter) from the 450SEL engine by giving it overhead camshafts instead. Fuel injection is standard—but note: Mercedes-Benz began using fuel injection so long ago (in 1954) that the 450SEL has passed beyond the computerized "little black box" concept to a CIS, or Continuous Injection System, of simplified *mechanical* design.

2 agile tons

If you could peek inside the 450SEL's 3-speed automatic transmission you would find that all shafts and gears in the mechanism are mounted on roller or ball bearings.

This two-ton automobile is maneuvered via a power-assisted steering system based on the recirculating-ball principle. You can ease from lock to lock in a mere 2.7 turns.

Count all the brakes

It is an intriguing fact that the 450SEL is fitted with *six* separate brakes, of two different types:

☐ Four disc brakes, each 11 inches in diameter, provide the basic stopping force. The front discs are honeycombed with internal ventilation slots for more rapid heat dissipation.

☐ Two drum brakes, one at each rear wheel, handle parking and emergency braking needs.

Velour, veneer, bituminous foil

Soft velour carpeting lies underfoot in the 450SEL. Also underfoot but out of sight: felt, foam-backed rubber matting and even *bituminous foil*, discreet allies in the engineers' quiet war against engine and road noise.

The built-in AM/FM stereo cassette unit has four wide-range speakers. Vacuum power instantly locks or unlocks all four doors, the trunk and the fuel filler port with the twist of a key. The built-in automatic cruise control device is a machine with a memory, able to return the car to a preset speed after you have speeded up or slowed down.

You can specify either leather upholstery or plush velour at no extra cost. You should know that inside the seats are five separate layers of padding and lining, laid overtop a network of steel springs.

Those rich fillets of trim that look like walnut veneer *are* walnut veneer. That dashboard clock is not a clock—it is a quartz-crystal chronometer.

Final revelation: The 60-page Mercedes-Benz brochure covers safety features built into the 450SEL and other models. This makes fascinating reading before you buy the car, and comforting reading afterward.

Engineered like no other car in the world

People give many reasons for choosing a Mercedes-Benz. But the company's aim in designing and constructing them is doggedly single-minded. It is to build safe, comfortable, practical cars with as few imperfections as possible.

This philosophy puts engineering ahead of petty economies and precludes the pea-pod mass production of inexpensive cars. It allows little room for compromise, none for shortcuts; just the pursuit of engineering excellence.

A Mercedes-Benz is engineered like no other car in the world.

Electric sunroof (shown) available at extra cost.

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Wesco windmill's rotor is hoisted into place near Efford, Hampshire (above). Smaller version of downwind rig was on view at London exhibition (left). Short aerofoil "cuffs" near hub make the windmill self-starting.

lem and have come up with separate solutions, both using hydraulic means. One obtains a flywheel effect to stabilize electric output. The other generates heat directly by hydraulic friction, sidestepping electricity entirely.

On a bleak hilltop near Boroughbridge, Yorkshire, I saw the first of these offbeat windmills. The 60-foot-diameter rotor with three fixed-pitch blades looks unusual itself, but the guts of the machine inside its 45-foot tower are unique. Through an opening in the corrugated iron paneling, I stared in amazement at a mighty pyramid of concrete paving blocks.

Constant electrical output

"That's our 'energy integrator,'" said Sir Henry Lawson-Tancred, designer of the mill. "It's a short-term energy store that smooths the wind's vagaries.

"The blocks are a 15-ton ballast weight suspended from the piston in an upright hydraulic cylinder centered in the stack," he told me. "The windwheel drives a bank of pumps feeding into the base of the cylinder, raising the piston and the weight. Fluid is then pressurized at 2500 psi, and that powers a pair of hydraulic motors driving electric generators."

I wondered: Why such a hefty device instead of the usual hydraulic accumulator using oil to compress a gas charge through a flexible membrane? "Here you get near-constant pressure—and therefore motor speed—regardless of fluid level," Sir Henry explained. "Also it's cheaper. And the weight helps anchor the tower in high winds."

The drawing shows a typical one-home installation with a five-kilowatt AC generator that delivers 240 volts at 50 Hertz (the British standard) for appliances and lighting. A second generator puts out 25 kilowatts for space heating and hot water, for which steady voltage and frequency are not critical.

Sir Henry's four-pump arrangement makes it possible to have fixed-pitch rotor blades, which greatly simplifies the design and cuts the cost. "That's because the load increases automatically with wind speed," he said. "That matches the revs to the wind, and also holds them to a safe level without having to feather the blades progressively."

The wheel runs at 60 rpm with a 20-mph wind. To prevent over-revving in high winds, the blades have centrifugally operated drag flaps that start opening at around 26 mph. At 35 mph, friction brakes stop the rotor.

Wind to heat

Geoffrey Pontin's Wind Energy Supply Co. at Peacehaven, Sussex, has developed a thermal windmill that uses a rotor-driven pump to convert wind energy directly to heat. The heat results from the friction of oil flowing through a closed loop of pipe under pressure. Such a one-step arrangement gives very high efficiencies because the additional thermal loss of intermediate electrical equipment is eliminated.

The first working prototype is installed at a British government experimental agricultural station near Efford, Hampshire. A 60-foot two-blade rotor on a 42-foot tower heats a half-acre greenhouse.

The unusual rotor has variable-pitch blades. Up to 30 mph, the blade angle is fixed and the revs are roughly proportional to wind speed. Above this point, the blades feather and the revs increase only slightly. This change is automatic, via an ingenious centrifugal governor. The blades are joined to the hub by a spring coupling with integral weights in a system that Pontin calls "torsional flexure." At high wind speeds the blades twist against the springs for automatic pitch change, eliminating the need for complicated mechanics or expensive controls.

In basic form the Wesco rig has a pump on top of the tower that circulates hydraulic fluid through a closed loop to an oil-to-water heat exchanger near the building. Flow to the exchanger is restricted by a throttle valve on the input side, creating a steady pressure build-up to 2000 psi. The high friction heats the hydraulic fluid to around 90 degrees C in a finned coil immersed

[Continued on page 192]

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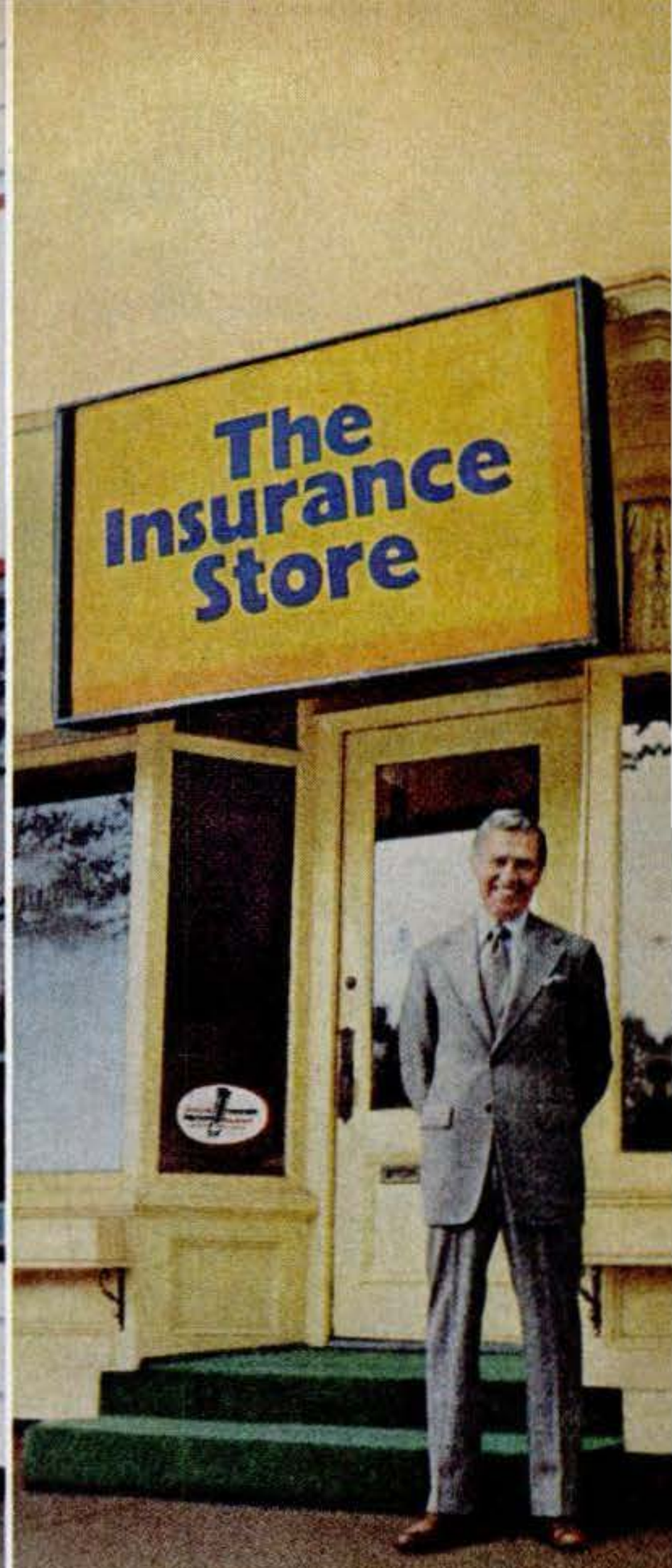
Company man.

Company man.



Companies man.

Who's the best man to see about insurance?

At Allstate, the agent can only sell the insurance of the company he represents.

At State Farm, the agent has the same limitation.

But The Insurance Store agent is different—he's not working for any one insurance company.

Instead, as an independent agent, he represents many leading companies—including Continental Insurance.

So he can help you shop for the specific company that offers you the best coverage. And the best service. At a reasonable price.

Maybe that's why so many people across the country do business at The Insurance Store.

To find the nearest Store, check the Yellow Pages for an agent listed under Continental Insurance.

Because he works for you. He's not just another company man.

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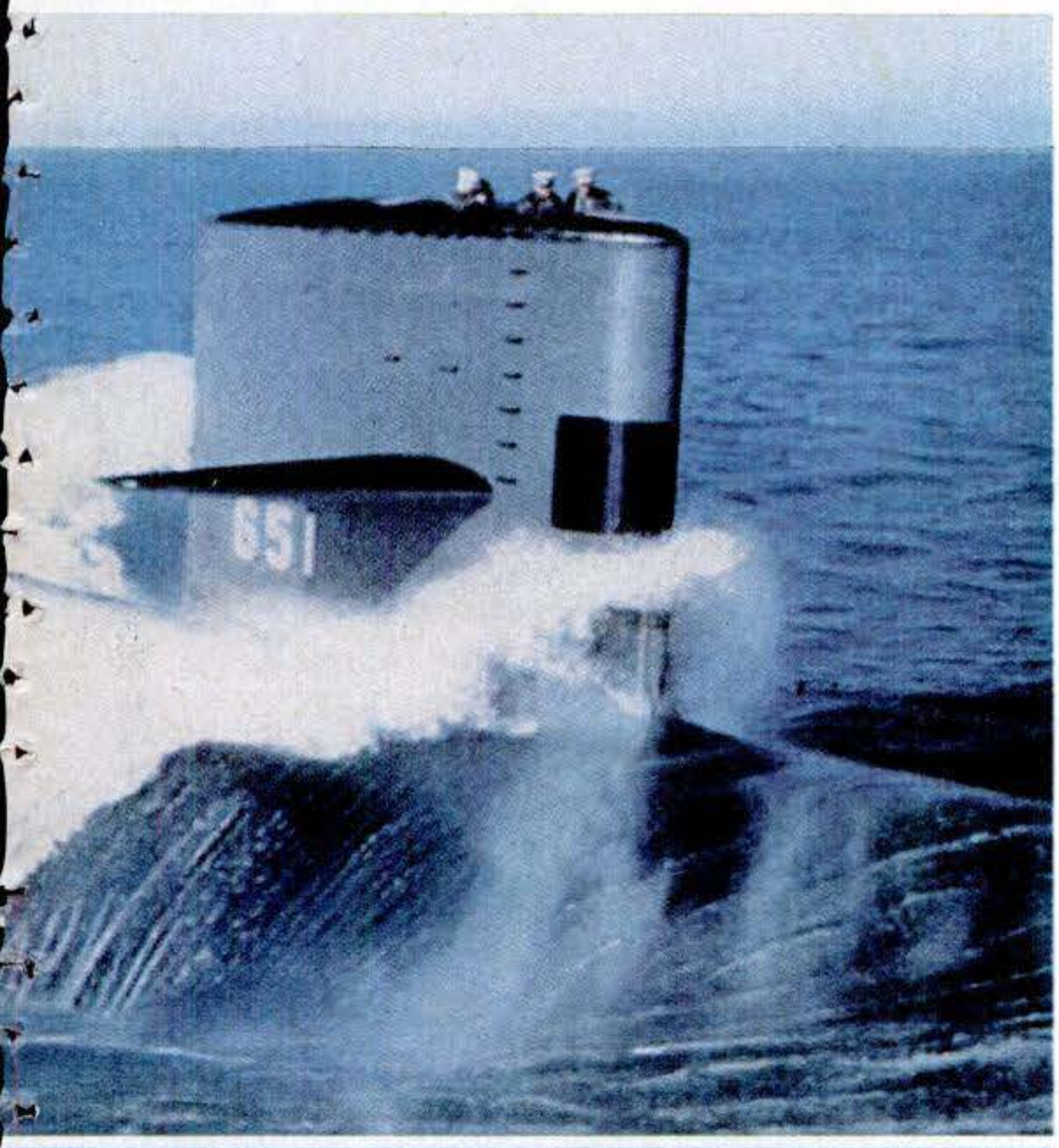

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Now compare that to some dull 9 to 5 job.

Army. Navy. Air Force. Marines. There isn't a job that can do more for you. Or a job that asks more of you.

For more information about service opportunities, fill out the postcard and mail it in.

Army
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Do it for yourself. Do it for your country.

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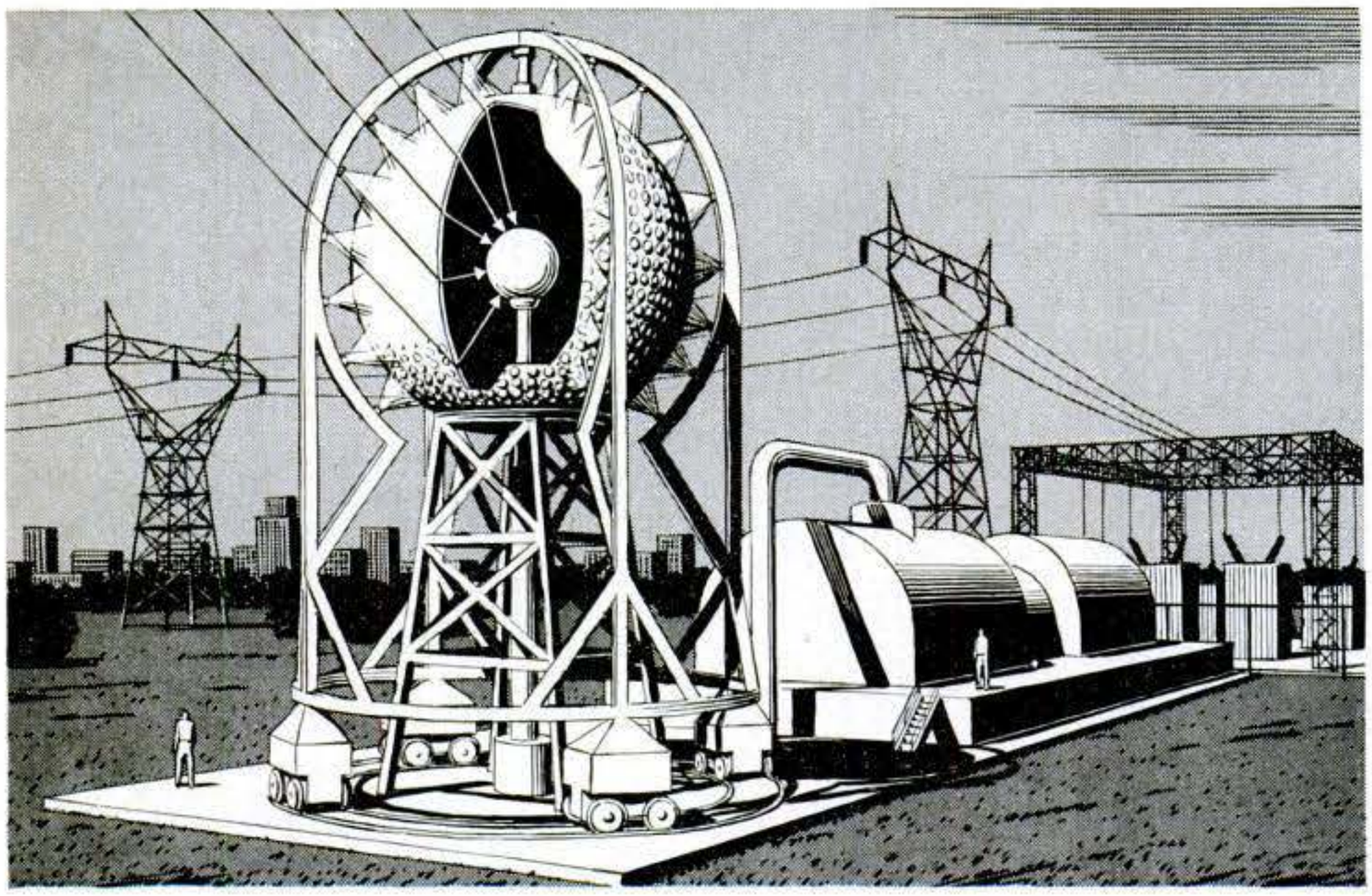
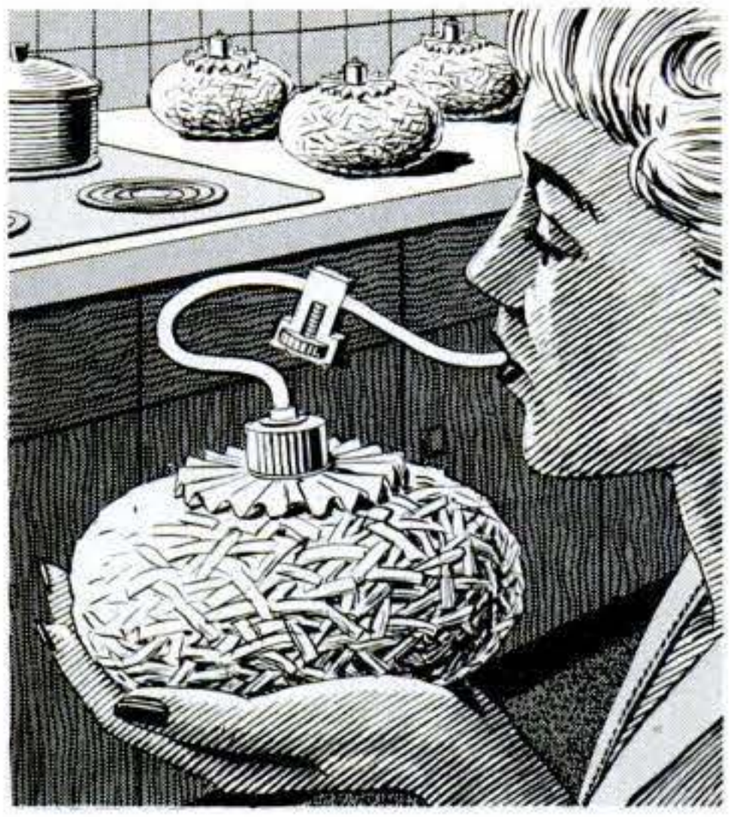
NEW IDEAS FROM THE INVENTORS

ILLUSTRATIONS BY RAY PIOCH



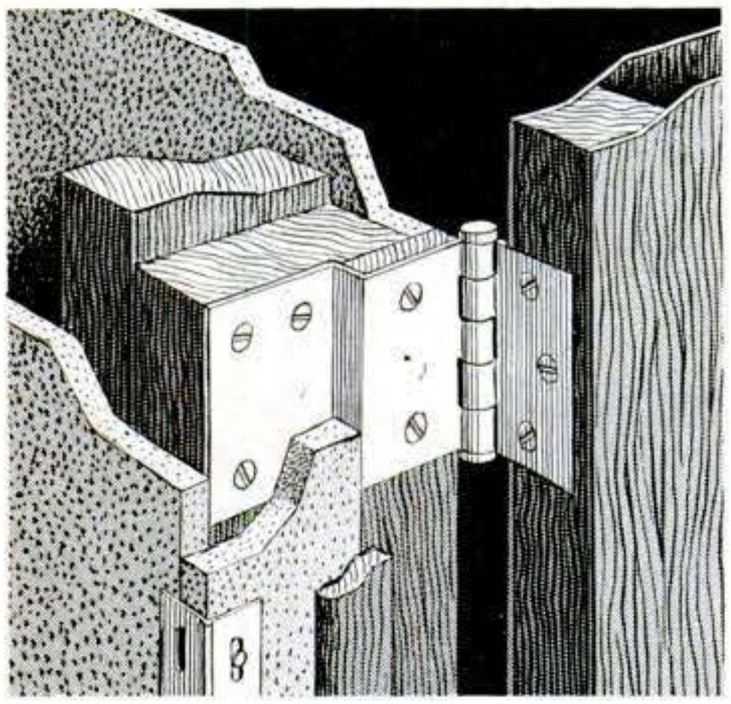
Solar concentrator keeps focused lenses clean

Arranged concentrically around the boiler of a generator, the spherically corrected lenses of this solar concentrator would focus solar rays on the boiler at the center of the sphere regardless of the sun's position in the sky. Thus the boiler collects energy throughout the daylight hours. As a further aid to efficient solar collection, the lenses would be kept bright by rail-rotated conduits that would spray their surfaces at night with cleansing water and warm air.



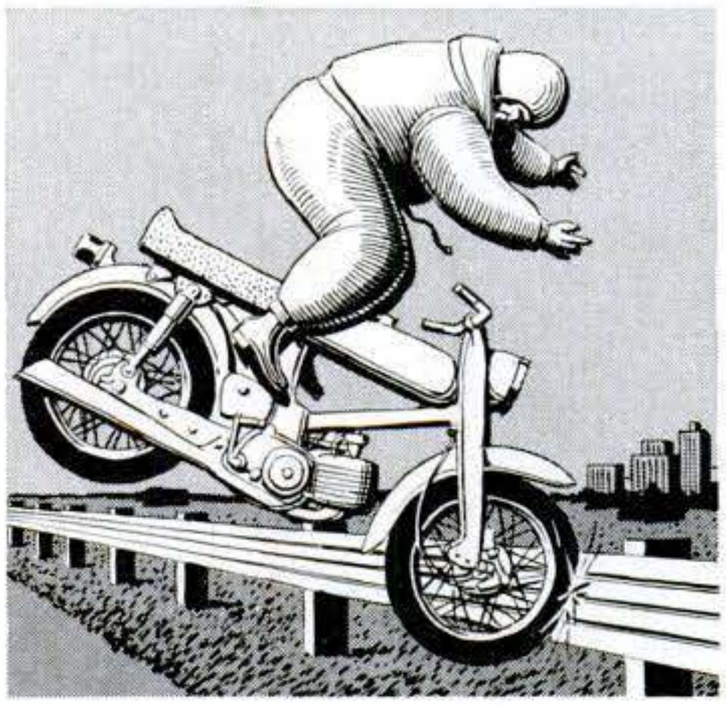
Nozzle evacuates freezer bags

Vacuum packing, says this inventor, helps to protect and preserve the flavor of frozen foods. To simplify evacuation of air from food packs, he'd fit an airtight collar around the gathered neck of a storage bag, then snap on a stoppered rubber tube. The trapped air inside the package could be evacuated by simple sucking. Then the package would be sealed and placed in the freezer.



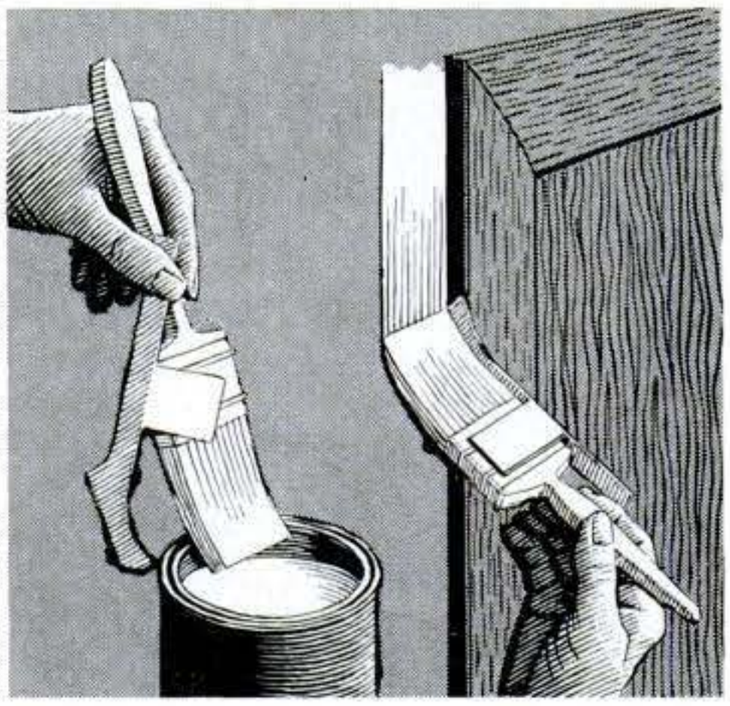
Hinge eliminates door casing

One face of the offset leaf of this lumber- and labor-saving hinge would attach directly to a stud instead of a costly jamb or casing, allowing it to be installed and aligned more quickly. The set-back portion could then simply be covered with plasterboard or drywall. The other leaf of the hinge would attach to the door in the conventional way.



Air jacket protects cyclist

A pressurized-gas system like that used in auto airbags would be built into this motorcyclist's jacket and triggered (as in a car) by sudden and extreme deceleration. Connected to a gas source on the cycle, the garment would inflate under circumstances that might throw a cyclist, then retain its gas volume even if disconnected from the source.



Brush guard follows trim line

With this bent-metal edge guard snapped onto the side of a paintbrush, you could run the brush quickly and accurately down a door frame or meeting wall with little risk of lapping the new color onto the old. The edge-following shield portion would pivot outward under thumb pressure so you could keep it clean when dipping and scraping the brush.

The following patents have been issued on these inventions: **Solar concentrator**—No. 3,934,573 to A. O. Dandini, Reno, Nev.; **Jambless hinge**—No. 3,969,846 to D. Scott, Akron, Ohio; **Cyclist's airbag**—No. 3,930,667 to A. J. Osuchowski, Detroit, and R. S. Lulenski, Warren, Mich.; **Evacuator**—No. 4,018,253 to S. I. Kaufman, Cote St. Luc, Que., Can.; **Paint edger**—No. 3,930,278 to R. A. Nasca, Painesville, Ohio.

Copies of patents may be ordered, by number, from the Commissioner of Patents and Trademarks, Washington, D.C. 20231, at 50 cents each. To write to an inventor, if address above is insufficient, address him by name and patent number in care of the Commissioner.

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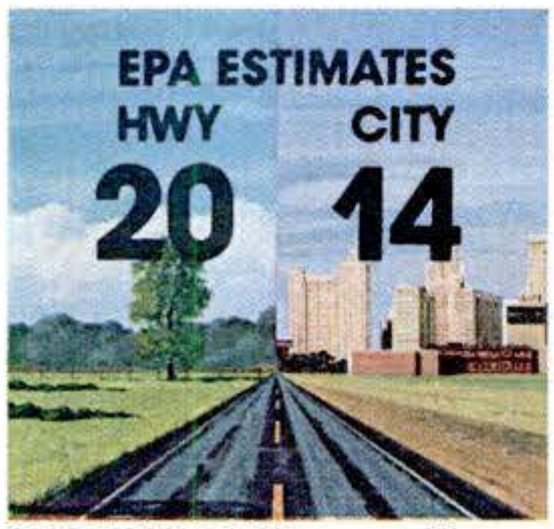
The New Chevrolet.

More of the things you want in a wagon.



MORE MILEAGE: Compared to 1976 full-size Chevrolet wagons. EPA estimates with the standard 305 V8 and auto. trans. Power train not available in California.

CONVENIENT DOOR-GATE. Opens out like a door for people. Drops down like a gate for cargo. Counterbalanced. Easy to operate.

ROOMY CARGO COMPARTMENT. Takes loads up to 4 feet wide through a rear opening that's wider at beltline, higher overall than the 1976 model it replaced.

PUSH-BUTTON SEAT CONVERSION. A lever releases the folding third seat back. A button high on the side panel lets the second seat fold forward.

LOCKABLE STORAGE UNDER THE FLOOR. 8.0 cubic feet on 2-seat model. Less on 3-seat model (shown).

LOCKABLE STORAGE IN THE SIDE. Over 2 cubic feet. Handy storage trays hold things that usually clutter seats and floor.

MORE MANAGEABLE IN CITY TRAFFIC THAN THE MODEL IT REPLACED. Something to appreciate as you slip into tight parking spaces.

SEATS 8 WITH AVAILABLE THIRD SEAT. Built to take big families with plenty of room for heads, hats, legs, and feet.

1978 Chevrolet Caprice Classic Wagon with available Estate equipment.

*Your mileage may vary depending on how and where you drive, your car's condition and available equipment. (Chevrolet is equipped with GM-built engines produced by various divisions. See your dealer for details.)

Introduced a little more than a year ago, The New Chevrolet quickly became the best selling full-size wagon in America.*

You can see some of the reasons for its success on this page.

The other reasons will become obvious the first time you test drive The New Chevrolet Wagon.

And the best place to do that is at your local Chevrolet dealer's Wagon Stop, your complete shopping center for wagons. *Based on R. L. Polk registrations for 1977 model year.

Chevrolet Wagon Stop

SEE WHAT'S NEW TODAY AT YOUR CHEVROLET WAGON STOP.

GM
MARK OF EXCELLENCE

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DETROIT REPORT

By JIM DUNNE

Smaller luxury coupes

The $10,000+ price of the Eldorado, Toronado, and Riviera luxury coupes won't go up much for '79, but the cars' sizes will go down. Like other GM lines that were shrunk in 1977 and 1978, the cars will be lighter, more compact on the outside, and will use smaller, more economical engines. The styling will be simpler, and the cars will look more like the current A-body coupes—Grand Prix and Cutlass Supreme—than their 1978 ancestors. The three will once again share the same basic body, and all will offer front-wheel drive (the Riviera did not have it in '78). The engines will be mounted in a fore-and-aft position, just as they are now. But engine size will be reduced considerably. The Eldorado will have a 350-cu.-in. V8 (down from 425 cu. in.), the Toronado will offer Olds' 260-cu.-in. V8 (instead of the current 403-cu.-in. V8), and the Riviera will get a turbocharged Buick V6 as its base power plant (it now offers a standard 350-cu.-in. V8).

Aluminum engines

The need to cut car weight to attain maximum fuel economy will result in the return of aluminum engines. Detroit is already using aluminum engine parts such as manifolds, transmission cases, and hoods. GM will be the first to introduce aluminum cylinder heads on certain engines, and Ford and Chrysler expect to follow suit. Eventually, aluminum engine blocks will be used as well. The first of these engines could be on the road in 1983, a target date for a number of changes at Ford, including the termination of its biggest V8 engines. Despite the problems encountered with the Vega engine, aluminum will work as an engine material: Witness the Porsche 928 V8 and the Mercedes five-liter V8, both all aluminum. Aluminum's weight-saving advantages can't be overlooked.

Mini-van holdup

GM's neat mini-van has been postponed. GM had planned to introduce the small van—which would eventually replace the present Chevrolet and GMC vans—in late 1979. It would have had a front-drive system based on the power train of the 1979 GM compacts. But new federal fuel-economy standards are being prepared for small trucks and vans, so plans are being delayed until the laws are set. Besides the mini-van, smaller full-size vans were in the offing. Now GM will wait to see whether it's best to bring out both mini and full-size vans or just one size. In any case, the big vans and their big engines that we have now will be obsolete by 1983. At that time the automakers will have to come up with new trucks that get 20-plus mpg rather than the sub-15 mpg of current vans.

Dual-displacement delays

Problems with poor fuel economy have slowed down Ford's plans to introduce its dual-displacement six-cylinder engine. Originally slated for vans early this year, the engines may not be installed until late 1978—if at all. Officially, Ford claims that the delay was caused by "paperwork" or "emission certification," but the real reason is that Ford is not getting the 15 percent fuel-economy increase that it hoped for. The engine is designed to run on three cylinders when cruising on the highway and to use all six when full power is needed, as in city driving. Ford has found that the engine has to work so hard to pull the big vans around that most of the time it's running on all six cylinders—so there is little benefit from the system. As a result, Ford is experimenting with a V8 engine equipped with a dual-displacement system. The V8's increased power will allow it to run on half the cylinders more of the time, it is hoped.

Beltless drivers

A massive advertising drive underwritten by the auto companies to persuade drivers to buckle safety belts was poorly received and may add fuel to the pro-air-bag camp's fire. Last fall, drivers in southeastern Michigan were bombarded with radio spots, TV ads, and billboards asking them to buckle up because "somebody needs you." The result after three months: Belt use increased from 14.7 to 21 percent. But that is far short of the 100-percent protection promised for air bags when they become mandatory equipment on new cars. It also takes most of the steam out of the auto makers' claim that occupants can be persuaded to use the belts already in cars. If they won't buckle up, the only way to reduce traffic deaths may be passive restraints like the air bag—or possibly the "automatic" seat belt/knee bar system used in the Rabbit.

Diesels at Chrysler

Chrysler is doing research and development on a diesel version of the 225-cu.-in. six-cylinder gas engine. Chrysler may also bring out diesel versions of its small V8's and the new four-cylinder engine now under development for the Horizon and Omni. The new four, scheduled to go into production in 1980, will be 122 cu. in. (two liters). It was originally planned as a gasoline engine only, but the potential for gains in fuel economy makes a diesel version attractive. A decision as to whether the new four or the small V8's get dieselized first will be made before mid-year. Chrysler could end up buying a four-cylinder or V6 diesel from outside the company instead of building one itself. The Rabbit diesel would just about bolt right in: It's built on the same block as the Rabbit engine that Chrysler already uses in the Omni/Horizon.

Rotary resurgence

Though GM suspended rotary-engine research last year, Toyota has become a believer in the rotary. Toyota is working on a high-fuel-economy rotary, but further improvement must still be made. Right now the Toyota rotary delivers 10 to 15 percent better fuel economy than Toyota's six-cylinder piston engine of the same power. But that is not good enough to compel Toyota to invest in the tooling needed to mass-produce the engine. A further 10-percent improvement is needed before Toyota will commit itself. The rotary is a Toyota design that uses the stratified-charge combustion process with both peripheral and side ports to place the intake charge in the best burning location in the combustion chamber. This is the key to the improvement in efficiency. The engine meets all the strict Japanese emission requirements for 1978 by using an air pump, catalyst, and thermal reactor.

Rabbit pickup

Rabbits are not the only models VW plans for U.S. production. A mini-pickup, similar in size to the Japanese trucks but different in other major areas, is a possibility for the U.S. assembly plant. It will use the Rabbit front-drive system and will be one of two front-drive pickups available in the small-truck market. (The Subaru Brat 4WD mini-pickup can be run in "2WD," which drives the front wheels.) The U.S.-built Rabbit sedans will be launched in this country first, and truck production will follow in 1979 or later. In the meantime, VW is looking at its other assembly plants around the world to see where truck production can be started. Late 1978 or 1979 is the soonest a truck built outside the U.S. could hit the American market. PS

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People write to PENNZOIL

Supreme Quality — Safe Lubrication

Have a question about motor oil? Lubricants? Engines? Ask the Pennzoil experts...

Oil Check. When is the proper time to check the engine oil level? Should the engine be cold, or is it better to check the oil after the engine's warmed up?

D.H.S., Skippack, Pennsylvania

The oil level should be checked after the engine has been shut down and has been allowed to stand for several minutes. This is to allow any oil that is hanging up in the cylinder or valve areas to flow back in the crankcase to ensure a more accurate level check. Another good time to check the oil level is in the morning before initial start-up.

Cadillac Question. I have a 1969 Cadillac with 100,000 miles on the engine, and use Pennzoil SAE 30. The engine is now burning about one quart of oil every 1,000 miles. The spark plugs show that the oil is getting by the rings. Do you think that a shift to Pennzoil 20W-40 would appreciably reduce oil consumption?

R.M.O., Bonita, CA

With 100,000 miles on your Cadillac engine, oil consumption of one quart of SAE 30 every 1,000 miles is not excessive. There's no harm in changing to Pennzoil Multi-Vis 20W-40, but we doubt if it would reduce the consumption rate. Since it is probably due to normal ring and intake valve guide wear, a heavier grade of oil would not correct it.

One's All You Need. The owner's manual for my 1974 Datsun B-210 does not list 20W-50 oil as an option. Can this be because 20W-50 oil was not readily available in 1974? Since I use Pennzoil 20W-50 in my 1976 Toyota pickup, I was wondering if it would also be satisfactory for my Datsun.

J.F.P., San Bruno, California

Datsun now shows 20W-50 oil as an option for all of their engines which would be retroactive to the 1974 B-210 for temperatures above 20°F. Our records show that the 20W-50 recommendation was first made in 1976, so you are probably correct in assuming that Datsun didn't recommend 20W-50 in 1974 because it was not readily available. You should enjoy good results using Pennzoil 20W-50 in your Datsun, as you have in your Toyota.

Follow the Leader. The manufacturers of both my 2-cycle lawn mower and power chain saw recommend oil especially designed for mixture with gasoline. Considering the higher price of this special oil I tried SAE 30 motor oil and mixed it with gasoline for use in both machines, and have obtained good results. Is there any real reason, therefore, to use the oil specified by the manufacturers?

C.F.D., Falls Church, Virginia

The general use of automotive engine oils in 2-cycle systems is not recommended. Automotive engine oils contain ash bearing materials which may contribute to plug fouling in 2-cycle systems. We recommend you consider using Pennzoil 2-Cycle Oil 50:1 for your lawn mower and power chain saw. Other oils may work satisfactorily for the time being, however, continued use of such products may have detrimental effects.

Short-Distance Runner. I have a 1972 Cadillac which I use primarily for short-distance, city driving in the Los Angeles area. The car accumulates only 4,000 to 5,000 miles per year. What oil and oil change intervals do you recommend for this type of driving?

L.A., Los Angeles, California

For your 1972 Cadillac engine, we would recommend Pennzoil Multi-Vis 10W-40 for maximum service and engine protection. Even though temperatures do not get below freezing in your area, this multi-viscosity oil will still give fast oil flow to engine parts on cool mornings at start-up, and then provide the protection of SAE 40 during warmer weather. With only 4,000 to 5,000 miles of operation per year and short trip driving, you may get more moisture condensation and fuel dilution in the crankcase than a car operating at higher annual mileages. Therefore, we suggest oil drain intervals every three months, with oil filter changes every other drain.

Long Cold Winter. Why does my car take so long to warm up? During the winter it took 15 to 30 minutes for the engine to get warm enough so that it wouldn't shake or stall.

R.C.W., Memphis, Tennessee

First, a well tuned engine helps insure faster warm-up and easier starts. You might have a mechanic check the following: 1) automatic choke mechanism–it should be closed when the engine is cold, open after operating temperature is reached; 2) proper carburetor float setting; 3) proper carburetor idle and mixture setting; 4) fuel lines, filter and carburetor should be free of dirt and water; 5) proper thermostat operation.

WE'RE OPEN TO QUESTIONS about motor oils, lubricants, engines. But, you can tell *us* a few things, too. Maybe you have discovered something interesting about motor oils or lubricants. Or you have a special reason for being a Pennzoil fan. We would like to hear from you. Write to: Pennzoil Company, Research Department, P. O. Box 808, Oil City, Pennsylvania 16301. Note: sorry no pictures or material can be returned. Letters chosen for publication are subject to revision necessary for publication requirements.

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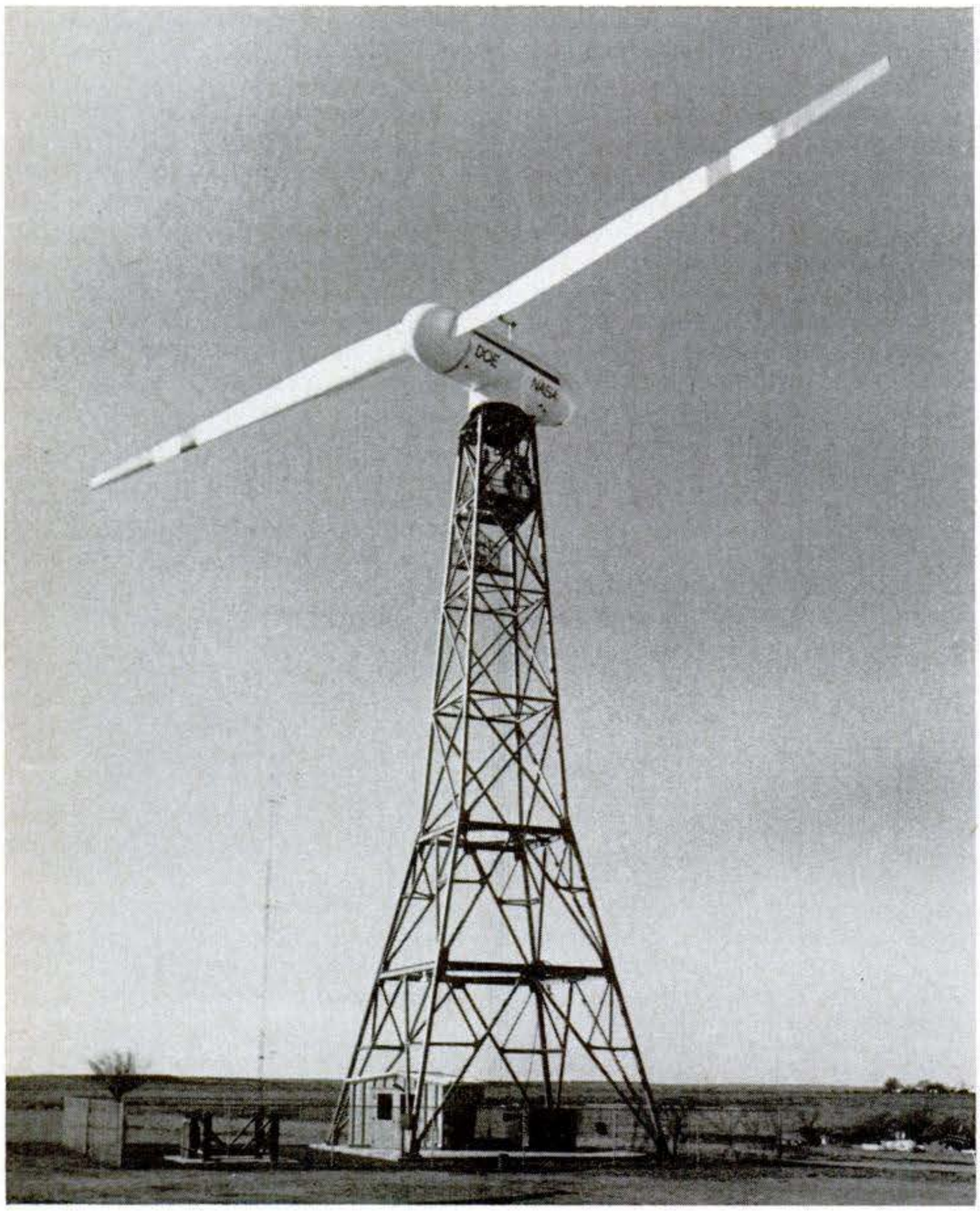
SCIENCE NEWSFRONT

By ARTHUR FISHER



New wind turbine on-line

Another in this nation's series of giant windmills has begun operating—but this time with a difference. By supplying electricity to the town of Clayton, N.M., it is the first federally sponsored wind generator actually to feed into a power system.

The Clayton wind turbine was designed and built for the Department of Energy (DOE) under the aegis of NASA's Lewis Research Center in Cleveland, Ohio. Like previous NASA-ERDA collaborations, it hews to the two-bladed approach; its design is similar to that of the experimental 100-kW prototype built (and still operating) at Sandusky, Ohio [PS, March '76]. With its 125-foot rotor (from blade tip to blade tip), the Clayton machine will generate 200 kW of electric power when the wind velocity is 19 mph or faster 30 feet above ground level. That's enough power to provide for the needs of some 60 homes. The small (3000 population) town in northeast New Mexico's ranching and farming country will continue to rely for about 85 percent of its needs on power generated by the municipal utility from oil and natural gas.

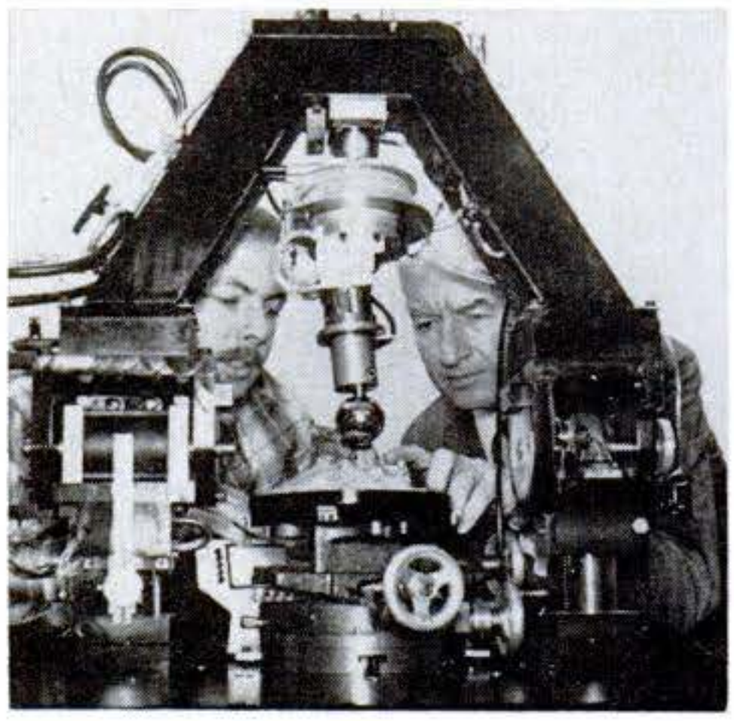
The huge wind turbine reacts automatically to changes in wind speed and direction. The rotor starts whirling when the wind speed exceeds eight mph, and stops when the wind tops 40 mph. A constant rotor speed—essential for a stable electric output if complex and expensive regulatory devices are to be avoided—is maintained at 40 rpm by a mechanism that automatically changes the pitch of the blades as the wind waxes and wanes. The rotor turns a horizontal shaft that drives an 1800-rpm electrical generator through a high-speed gearbox. Result: 200 kW of stable, 60-cycle AC power.

A second 200-kW wind turbine will be installed on Culebra Island, Puerto Rico, in mid-year, and a third will loom over windy Block Island, R.I., later this year. A much larger, third-generation model will be built near Boone, N.C., late this year. Its rotor will span 200 feet, and it will generate a hefty two MW, enough for some 500 homes.

Hip simulator

A machine built by mechanical engineers is helping researchers at Massachusetts Institute of Technology probe the causes of a widespread and crippling form of arthritis. In osteoarthritis of the hip, the hip joint simply wears out—often without apparent cause.

With the hip simulator you see in the photo, the MIT researchers have



learned that the pressure exerted by the thigh bone against the hip socket, rather than being fairly uniform as previously suspected, is quite irregularly distributed, probably because of abnormalities in the geometry of the joint.

The hip simulator is used to study actual hip sockets removed from human cadavers. The small metal ball you see is a Moore prosthesis, a device used to replace the top of the thigh bone in the surgical correction of some hip conditions. The MIT engineers built 14 sensitive pressure gauges into the ball, and connected their outputs to a computer. The simulator moves the ball within a hip socket, mimicking a normal walking cycle that exerts pressures of three to five times body weight on the joint. The computer then produces "maps" showing the distribution of pressures throughout the socket. Eventually, the MIT researchers will implant such a prosthesis and a tiny FM transmitter in a patient who needs hip surgery.

Taming the whirlwind

For some years now, aircraft designers and safety experts have been trying to tame the whirlwinds that accompany

Continued

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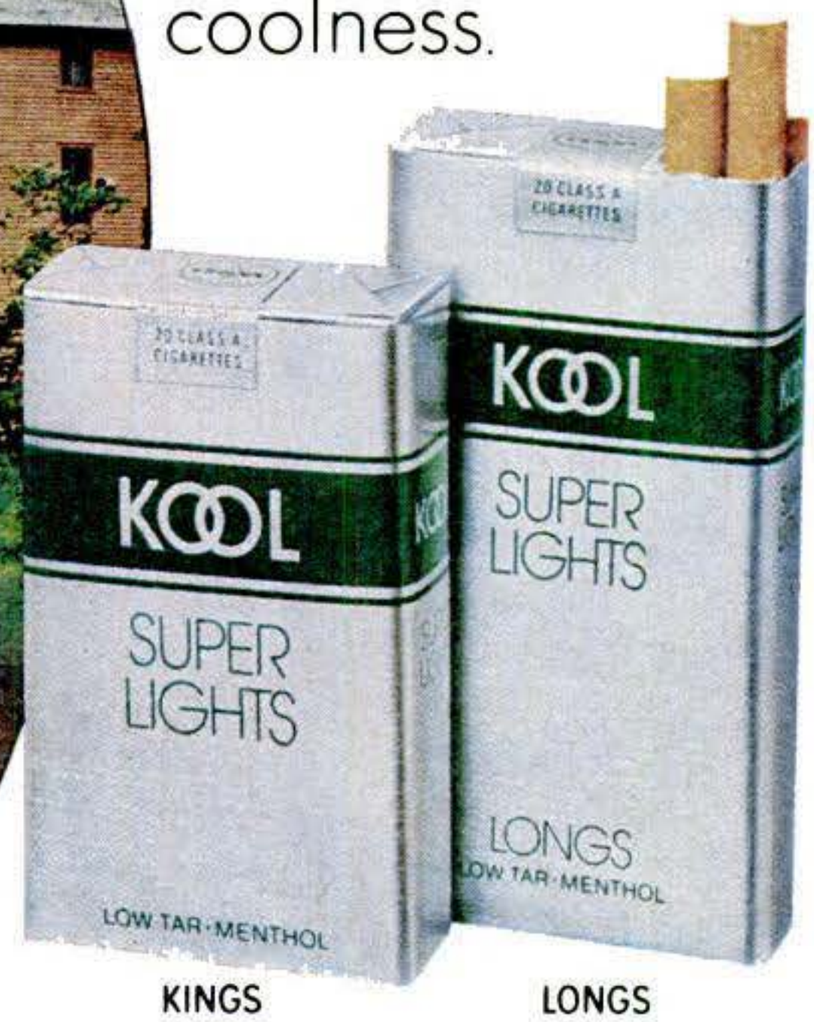
Discover the most refreshing low 'tar.'

KOOL SUPER LIGHTS

No other low "tar" refreshes like KOOL SUPER LIGHTS. But then, no other cigarette has its special kind of coolness.



KINGS LONGS

©1978 B&W T Co

America's most refreshing low 'tar' cigarette.

mg. 'tar' in both sizes.

Warning: The Surgeon General Has Determined That Cigarette Smoking Is Dangerous to Your Health.

9 mg. "tar", 0.8 mg. nicotine av. per cigarette, by FTC method.

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COMPARE!

Coleman® Poly-Lites®: Feature for feature, dollar for dollar... the best values under the sun.

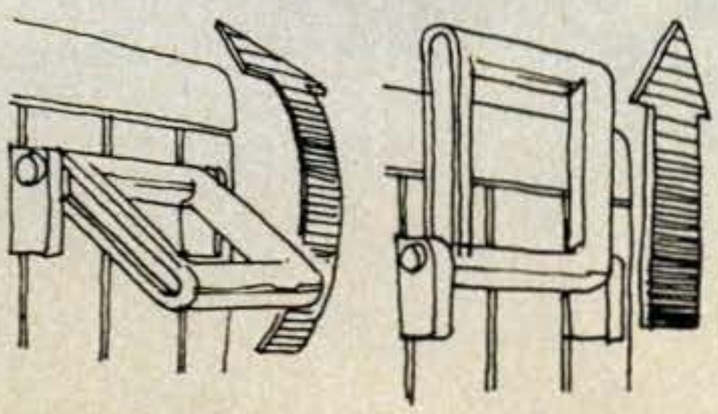
These are the ones that proved just how tough "plastic" coolers and jugs can be. How efficient in holding the cold. How good-looking. Yet when it comes to price, all that separates 'em from the herd is a buck or so. Maybe even less.

So take a close look at a Coleman Poly-Lite, like our 12-gallon model shown here.

Start with the most basic point. All Coleman coolers and jugs are insulated with urethane, the best material available. And lots of it. So they *hold* the cold.

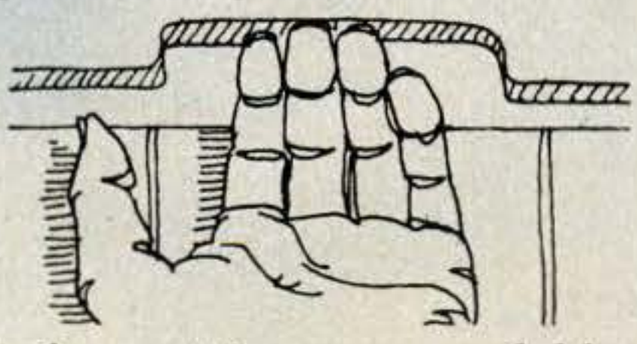
Next, think *tough*. That high-density polyethelene hide shrugs off all the rocks and hard places. Keeps its bright color in the sun. Won't rust or corrode, even in salt water.

You'll also find special touches. Like handles that are smooth and round, won't pinch. They swing



out for carrying, like on most coolers. But they also lift straight up for tight places, like a car trunk.

The snap latch is fumble proof, *inside* the lid where it can't break off. Close the lid firmly for traveling. Softly, and you get the "quick-seal" position so you can open it easily with one hand.



And something new available as an accessory: the Cool-a-tray. Fill it with water, freeze it—and it provides extra cooling power for meat, cheese, other perishables.

Poly-Lite coolers and jugs. Sizes, styles, colors for anyone. And the price is right.

Remember: Coleman equipment can come in handy in storms, blizzards and power losses too.

The great outdoors is too good to miss.

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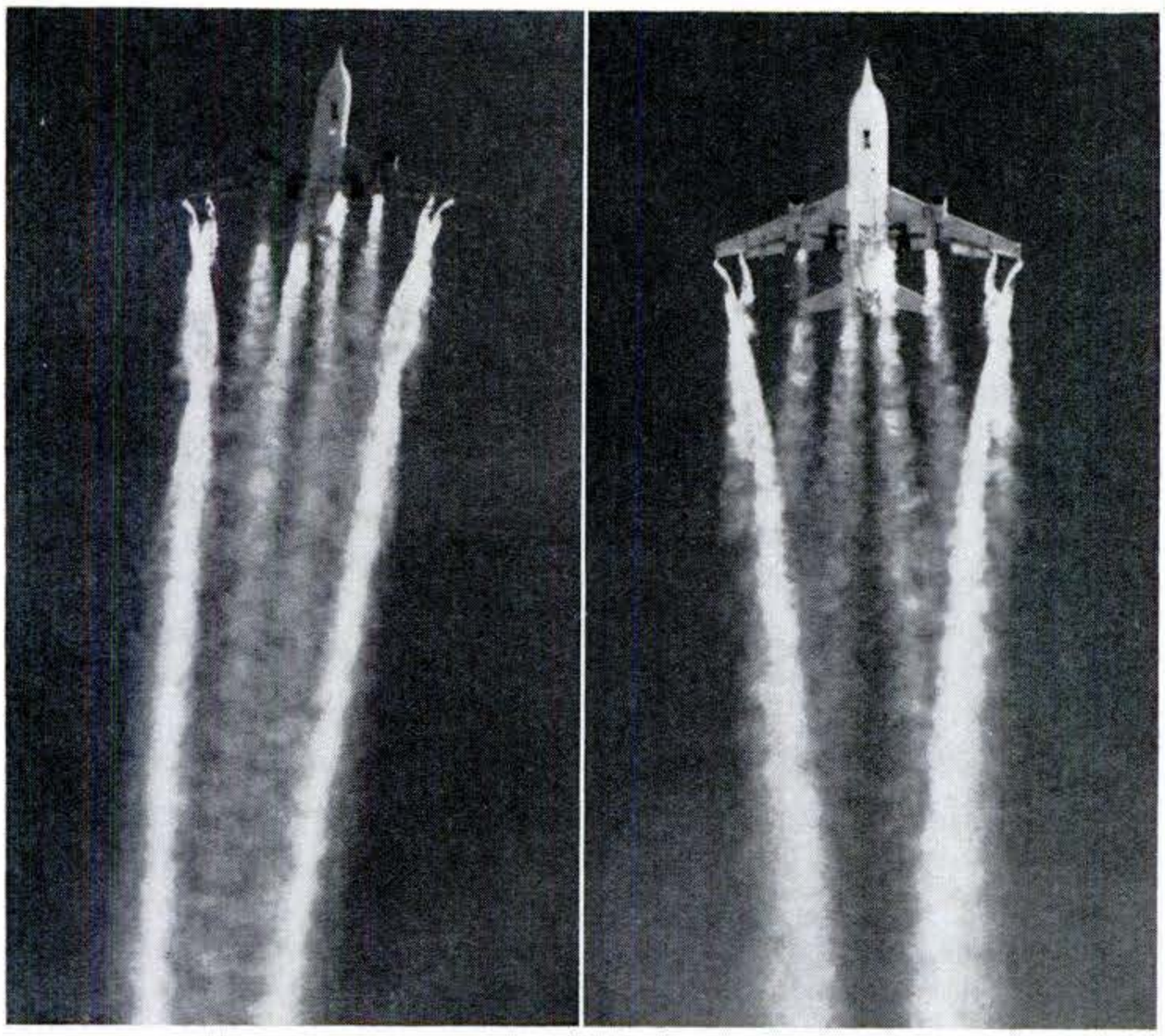


giant wide-bodied airliners. These strong rotary air currents, or trailing vortices, were first discovered when small planes, attempting to land too close in the wake of the giants' own landings, were severely buffeted and sometimes dashed to the ground. The use of smoke trails proved the vortices' existence [PS, April '71].

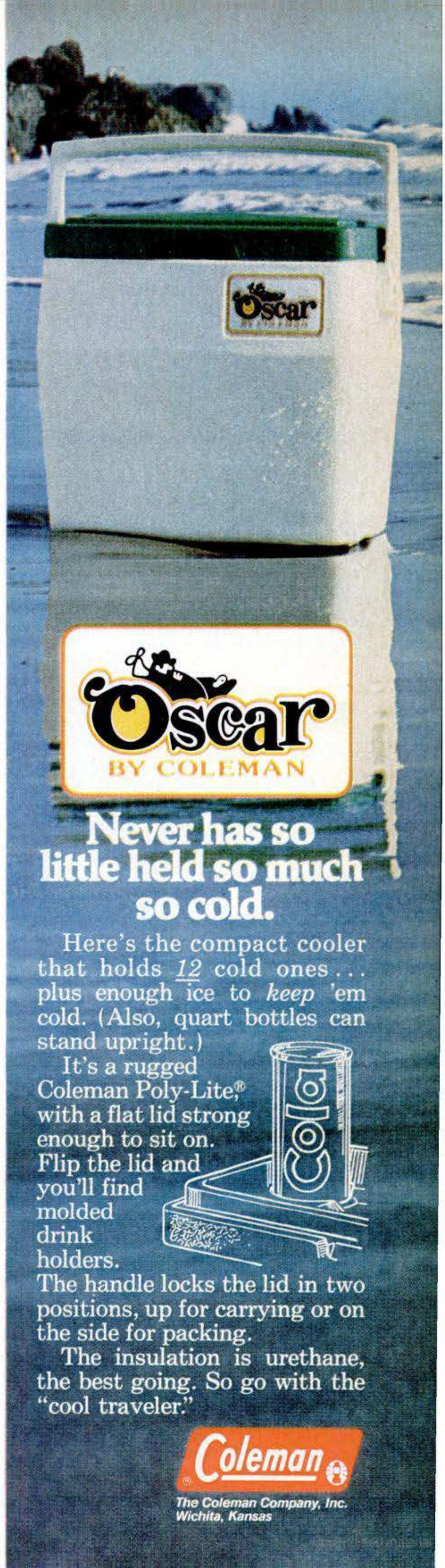
Now tests at NASA's Dryden Flight Research Center at Edwards, Calif., have shown that various spoiler configurations can help in breaking up the destructive turbulence. The two photos above illustrate some of the test results. At left, smoke trails from an L-1011 in regular landing configuration show how the vortices stream behind the plane. At right, six of the craft's 12 spoilers are raised on landing. Now the smoke trails show the vortices intertwining and diffusing much closer to the L-1011, thereby reducing their potential for damage to following planes.

Personal breathalyser

Had one too many for safe driving? This electronic breath tester, developed at Sweden's Lund University, lets a driver know before he drives. The unit's calibration can be set to accord with local law governing permissible blood-alcohol levels, or with whatever you think is prudent. For example, you puff into the mouthpiece and a green "safe" light flashes if the level is below 0.04, an amber warning if it's from 0.04 to 0.08, and a red danger signal for anything above 0.08. The tester has a solid-state sensor that changes in resistance on exposure to the gases present in an alcoholic breath. Its output is converted into a variable DC voltage that actuates one of the three colored light-emitting diodes, depending on alcohol intake.

Noted without comment

The American Chemical Society reports that its Chemical Abstracts Service has recorded the four millionth unique chemical substance in the file of its computer-based chemical registry system. That is the total number of different chemicals described in the world's scientific literature since January, 1965. PS



ADVENTURES IN ALTERNATE ENERGY

A monthly sampling of projects PS readers have devised to conserve or replace fossil fuels

Charles Curnutt: Tracking solar furnace

By GERALD FOSTER

TWENTYNINE PALMS, CALIF.

While utilities in the Southwest probe the feasibility of "solar-powered towers" with multimillion-dollar pilot projects [PS, Oct. '75], Charles Curnutt has spent $250 for materials to operate a tracking solar furnace that can generate the equivalent of 6200 watts—enough to supply the heating needs of a typical home.

A manufacturer of motorcycle shock absorbers, Curnutt recently moved his plant to the desert in order to spend more time on solar projects. "In building this furnace,"

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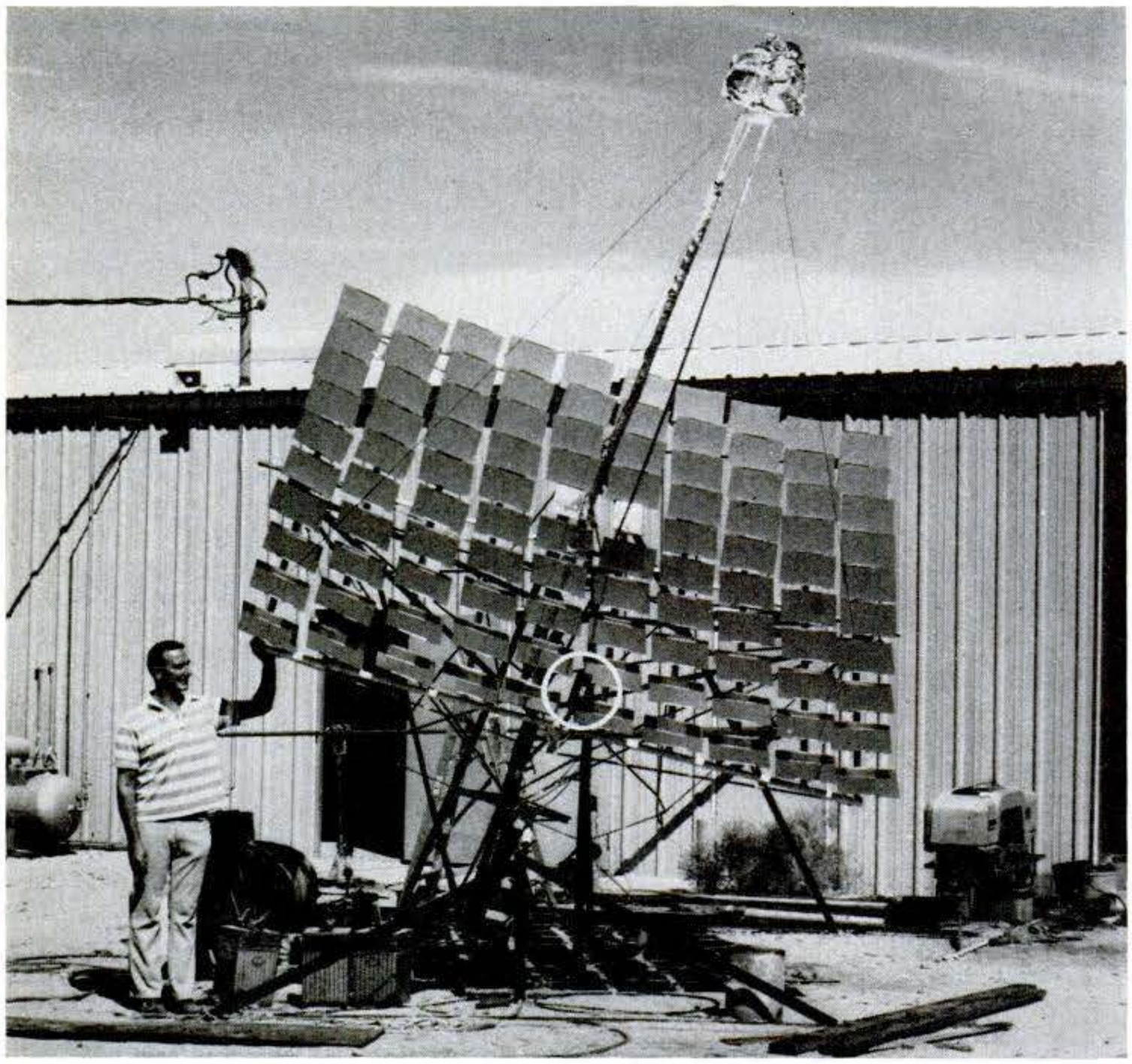
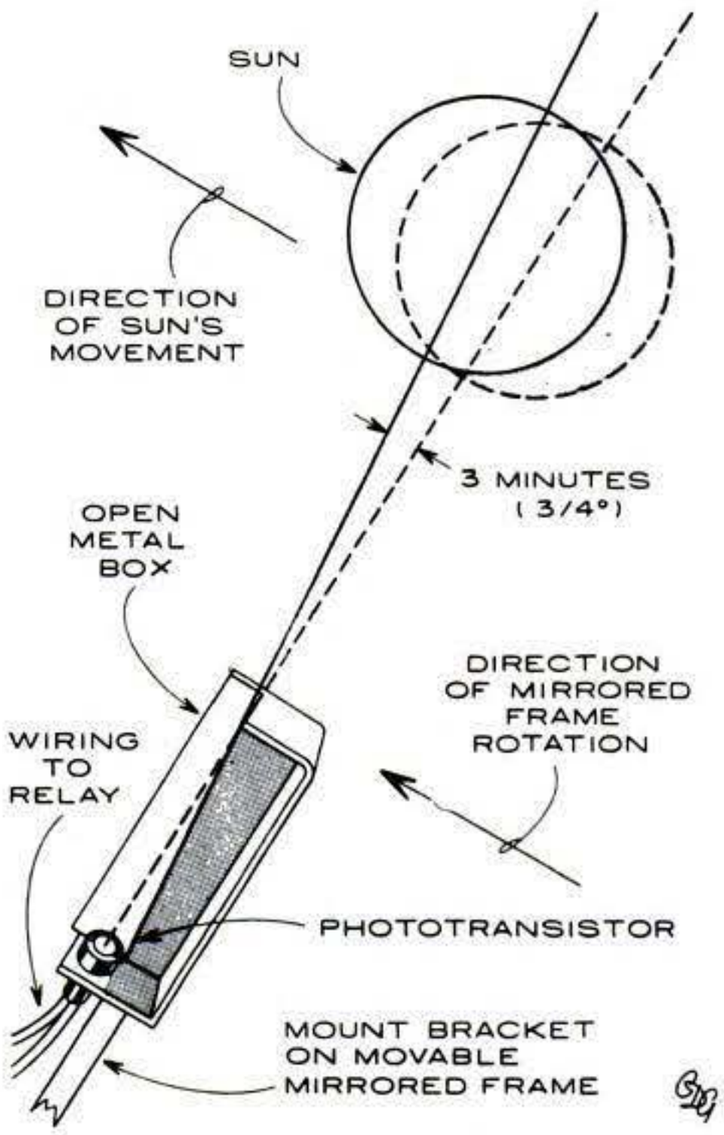
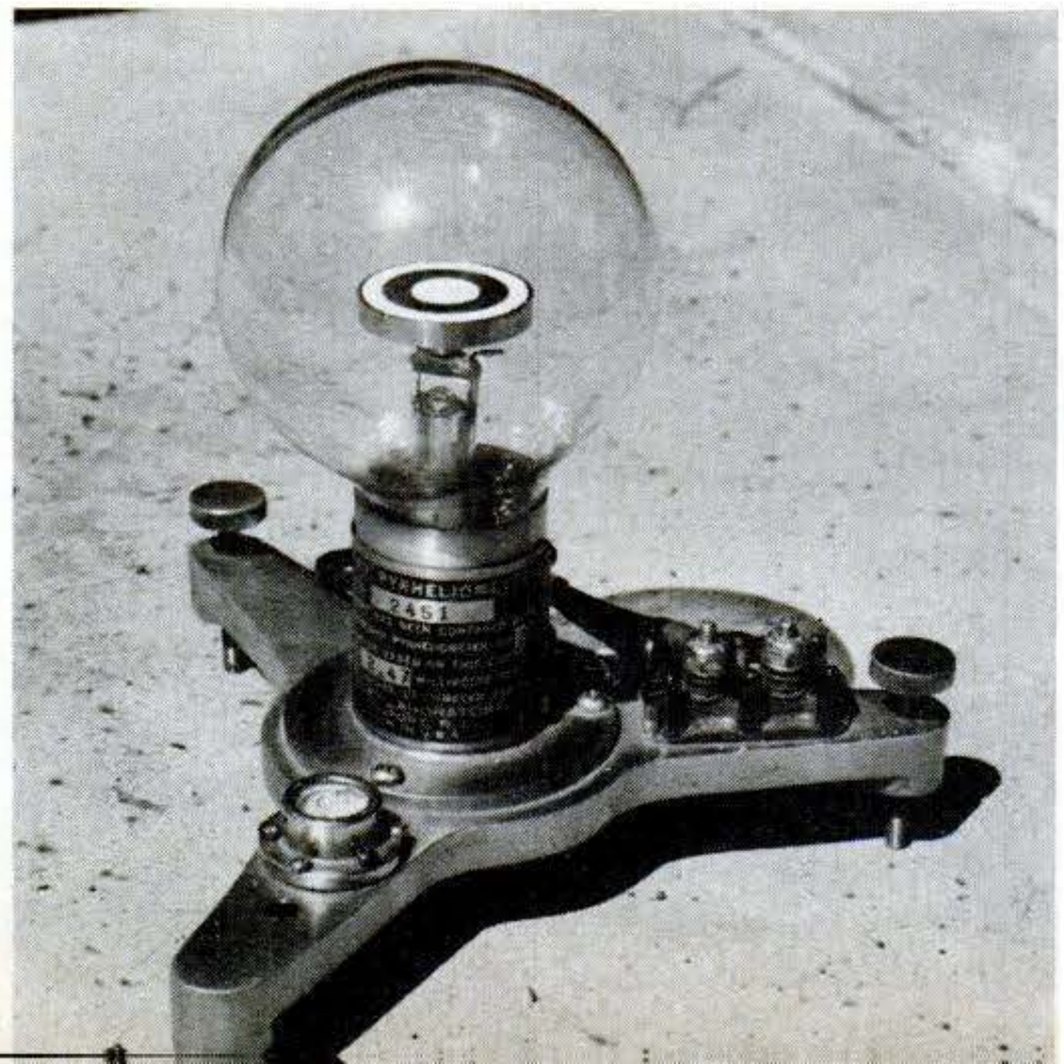


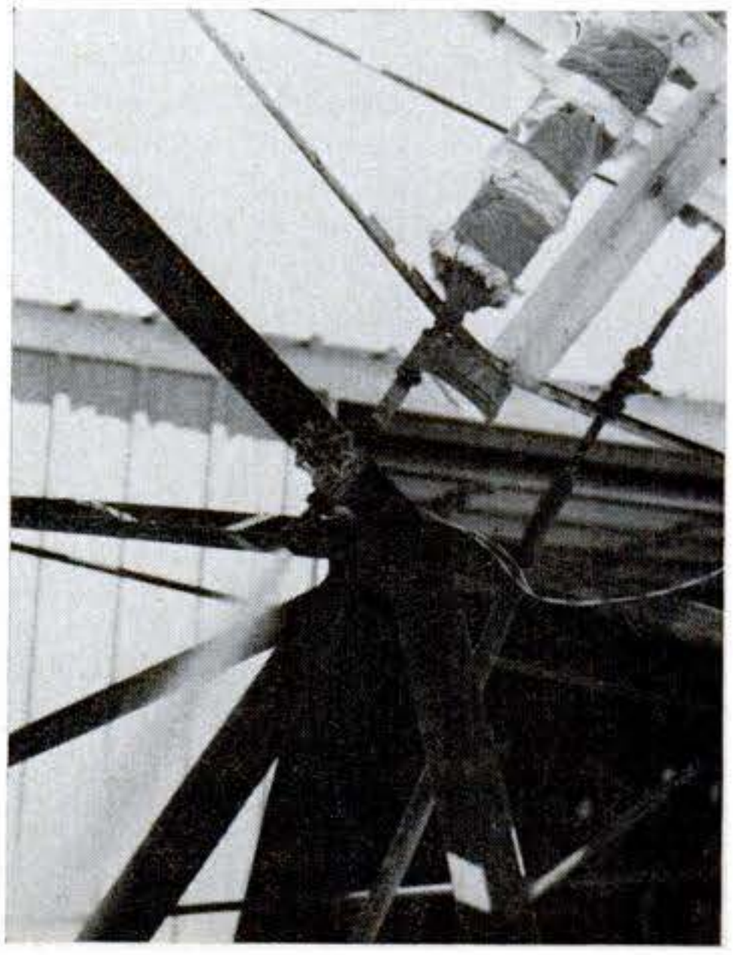


Metal box (above) shades phototransistor as sun moves through sky, causing mirror array to track sun. Box is circled in photo at left. Furnace pushes enough steady steam through outlet (below) to run 1¼-hp engine (not shown).

One hundred mirrors focus sunlight onto water-filled boiler at top of array. Since heat is concentrated on very small area, insulation requirements are not as crucial as for flat-plate solar collectors.



Pyrheliometer resembles oversize light bulb (right). Device measures intensity of sun's rays in watts per second per square centimeter. Curnutt multiplied this figure by total area of mirrors to find theoretical power available.



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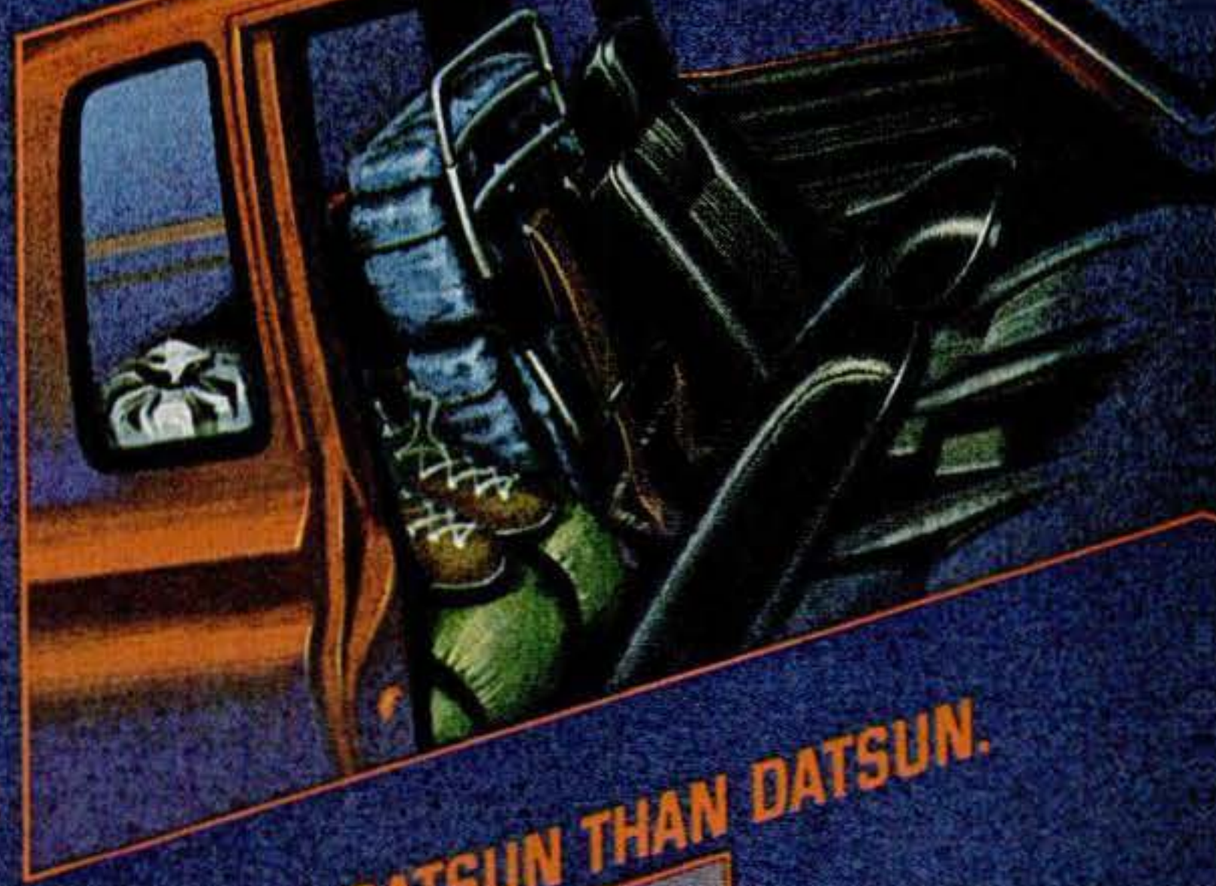
IT'S A CAR. IT'S A TRUCK. IT'S A FIRST.



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PEAK PERFORMANCE.

Honda portable generator scales Mt. Everest without skipping a beat.

When you set out to climb a 30,000-foot mountain, you can't take a lot of stuff with you. Food, clothing —and a few necessary tools to get the job done.

One thing the American Bicentennial Everest Expedition had along was a Honda EM-400 portable generator. At the 18,000-foot base camp, the little Honda put out dependable power for charging batteries, running a soldering iron—even powering the radio to keep up vital communications.

The EM-400 puts out 400 watts (max. rating) of AC power; it'll power small tools and accessories around the home or campsite. It also puts out 12 volts of DC power, so it will charge your car battery as well. It's simple to use; the quiet Honda engine is a four-stroke design so you never have to pre-mix fuel. And at a mere 39 pounds, it's easy to store and move.

Check out the Honda EM-400 at your Honda generator dealer today. It's a nice companion to have, whether you're climbing a mountain or just getting the odd jobs done at home.

HONDA
GENERATORS

For optimum performance and safety we recommend that you read the owner's manual before operating the unit. For the Honda dealer nearest you, call collect (213) 381-2201. Honda also makes a line of tillers, outboard engines, general purpose engines and water pumps.
©1978 American Honda Motor Co., Inc.

he says, "I started with the premise that it had to be inexpensive and that it could be built by anyone with access to welding equipment and hand tools."

One hundred 12-by-12-inch mirrors (50¢ each) are focused on the base of a steel boiler mounted 12 feet away on a boom. The array of mirrors is attached to a 10-foot-square tubular frame that pivots on an angled stand. Spring-loaded mirror carriers welded onto steel stems grip the mirrors on two edges, allowing easy replacement in case of damage. Balanced with a corresponding weight of concrete blocks below the pivots, the frame is set equatorially by hand, but tracks automatically using a 79¢ phototransistor.

When the frame is in a stationary position facing the sun, the phototransistor is in the shadow of a metal cover (see drawing). As the sun moves, light causes the phototransistor to energize the power relay of a 12-volt windshield-wiper motor. Operating through a rope drive, the mirrored frame rotates until the shadow again falls across the phototransistor, opening the circuit and stopping the motor. This happens about every three minutes.

Curnutt chose a rope over a chain drive to reduce the chance of damage by a sudden gust of wind blowing against the sail of mirrors. A rope drive, which can slip, permits the frame to turn end-on, presenting a much smaller surface to the wind.

At the end of its rotational movement, the frame trips a light switch, reversing the motor and automatically presetting the mirrors eastward for the next morning.

Performance over the last year has been impressive enough to convince Curnutt to install the system in his home. He figured efficiency by calculating temperature differentials and using a pyrheliometer. When I visited the project, the output measured 6200 watts out of a possible 7660—an amazing efficiency rating of 81 percent. That figure would have been even higher if Curnutt had painted the bottom of the boiler black and insulated the water lines better. Curnutt calculates that a furnace of only 50 square feet (3000 watts) could provide sufficient hot water for a typical home.

To ask a specific question, send a stamped return envelope to Charles Curnutt, 75992 Baseline, Twentynine Palms, Calif. 92277. PS

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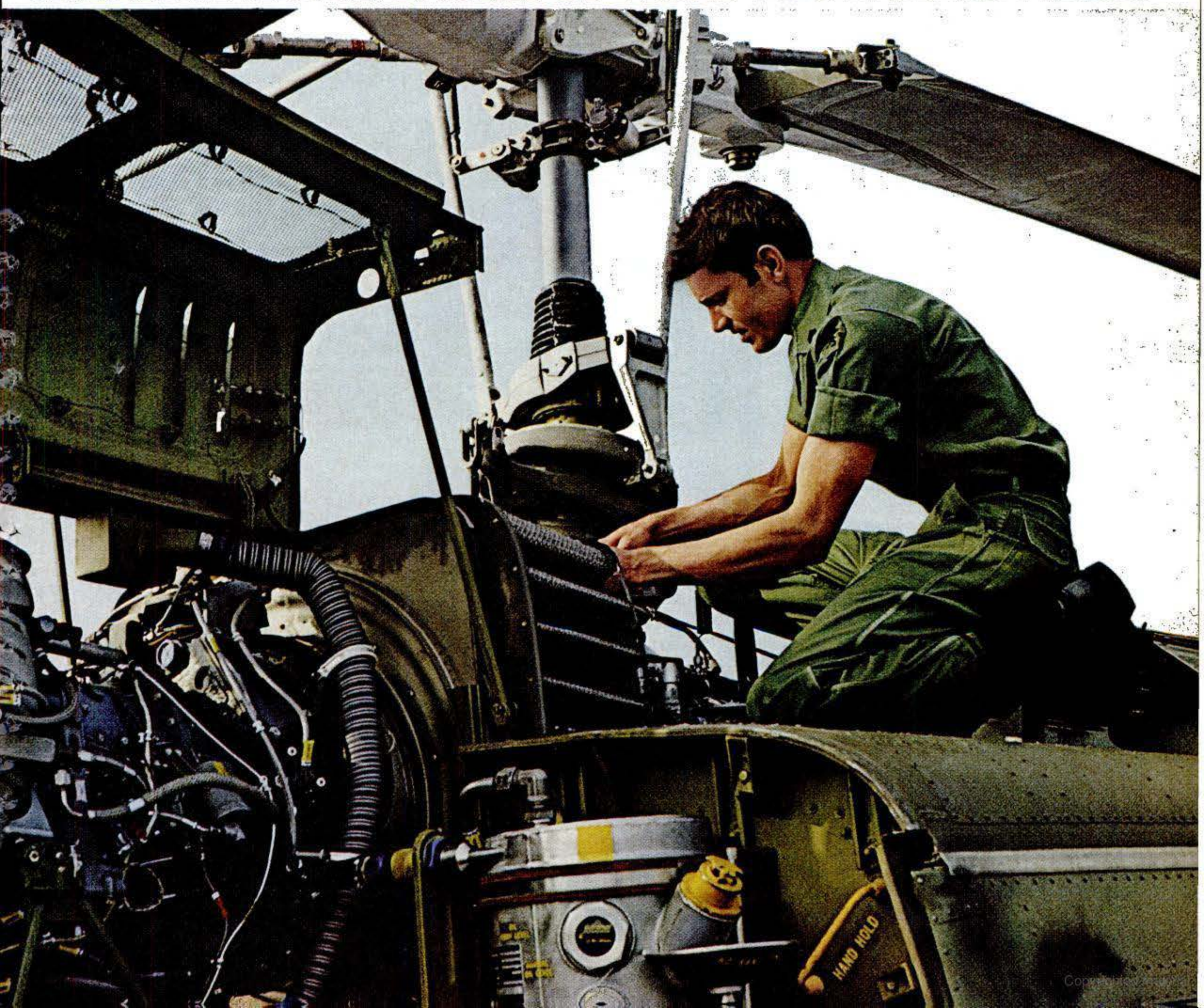
But you'll find it's time well spent. Because, when you come home, you'll have not only a part-time job with full-time pride, but a skill you can use in civilian life, too. For more information, send the attached postcard or call 800-431-1234 toll free. In NY call 800-243-6370.

THE ARMY RESERVE. PART OF WHAT YOU EARN IS PRIDE.



BOATING BEAT

By BOB BLACK

Show bonanza

As I prowled the recesses of this year's midwinter marina at the New York Coliseum, where the National Boat Show is staged, I found new boats of all types, plus new engines and electronics. Some of this year's finds:

- Another new little sailboat from Boston Whaler. The 15-foot Harpoon (called the 4.6, its length in meters) has a beam of 6'6" and carries 130 sq. ft. of sail. It looks fast and strong.
- Glastron has produced a high-performance bass-boat/ski hull that it says is unusually stable and has good rough-water handling characteristics. The bass-boat model (photo at bottom) is laid out for all the fishing extras aboard. A Fish & Ski model is outfitted for performance skiing and family cruising. Length is just under 18 feet, and the transom's a wide 90 inches. Both models have dual-cable steering with a rubber sport wheel, 25-gallon fuel tank, recirculating livewells, outside hand and side rails, ice chest in floor, and carpeting throughout—all standard. Power range is from 115 to 175 hp.
- Cruisers, Mirro Marine Division, has come up with a 22-foot Barnegat that's available in three models: offshore cruiser, camper, and fishing utility. The company, long active in the trailerable midsize field, now also has its first wide-body cabin cruiser, the VillaVee 288, which has a 28'8" centerline and 19'8" beam. It may be tight sleeping the six people the company says it will handle, but the boat certainly looks well-thought-through. Jim Wynne designs the hulls for Cruisers—all deep-V jobs.
- Chris-Craft has a new 24-foot Lancer Transdrive Express and a new 38-footer, the Corinthian long-range family cruiser. The Corinthian is said to be capable of planing or sustaining cruising at nine to 15 knots. Jim McQueen, Chris-Craft president, says it "brings a totally new concept to the trawler principle—it offers houseboat space with long-range potential, enclosed in cruiser lines far more attractive than the traditional trawler."
- Uniflite showed a new 38-foot convertible sedan as well as a new 26-foot family sedan. Both carry the label of Underwriters' Laboratories (UL) that attests to their fire-retardant construction and hull strength. Uniflites are the only powerboats to carry both of these UL approvals.
- Bayliner Marine had the largest exhibit—19 boats, of which eight are new: six new powerboats from 15 to 27 feet; two new sailboats, one an 18-, the other a 29-footer. The Seattle, Wash., company, with sales in the $60 million range, is now one of the two or three largest boat-building firms in the world.

A folding dinghy

The Voila is not brand-new on the scene, but we've not reported on this novelty earlier. Jean Lacombe, a veteran sailor who has soloed the Atlantic five times in boats of under 23 feet, designed this folding dinghy (above), which could fit under a berth. The hull folds to a 38-lb. package, 6'3" by 19" by 2". The transoms and thwarts make a smaller flat package, and you can assemble it all in about five minutes.

It is not an oddity, but designed to carry three people. It's made of varnished, five-ply, first-grade mahogany marine plywood. The folding seams are made of several layers of specially bonded high-grade nylon-neoprene cloth. All hardware is brass, bronze, or stainless steel. It'll even take a two-hp outboard. Price is $550. Lacombe Marine, Ltd., is at 695 Washington St., New York, N.Y. 10014.

V6's and diesels

Johnson Outboards has come up with a 150-hp V6—and V6 engines are the big news in outboards this year. The Sea Horse 150, which is similar to Johnson's 175-hp, was designed to power the growing number of boats—including many bass boats—rated for 150 hp. Evinrude is also introducing a 150-hp rated at 5000 rpm.

And speaking of engines, Bill Winemaster, vice-president of Perkins Engines, forecasts a 20 percent jump in sales for marine diesels this year. He attributes this to the increase in diesel cars. "People are reading everywhere about diesel dependability and fuel economy, and we believe all of this attention is bound to make even more people want the advantages of diesel power in pleasure cruisers, sailboats, and workboats."

And some accessories

- Narco Marine has an EPIRB—an emergency position-indicating radio beacon that alerts and signals aircraft for fast location of boats adrift or in danger of sinking. It automatically signals the boat's precise location, speeding up the rescue process. No search is necessary, because Coast Guard rescue craft fly directly to the beacon.
- Kenyon Marine has introduced a new digital speedometer, the KS 300D, incorporating a new generation of liquid crystal display (LCD) that requires only microwatt power.
- Ray Jefferson has a new waterproof, advanced-design fish flasher, the Bumblebee 70, that is unaffected by morning dew and moisture and will float if dropped over the side. It's good to 70 feet.
- Pearce-Simpson has the Bimini RT—a fully transistorized 12-plus-two-channel radio telephone pretuned to six channels and both weather frequencies. PS

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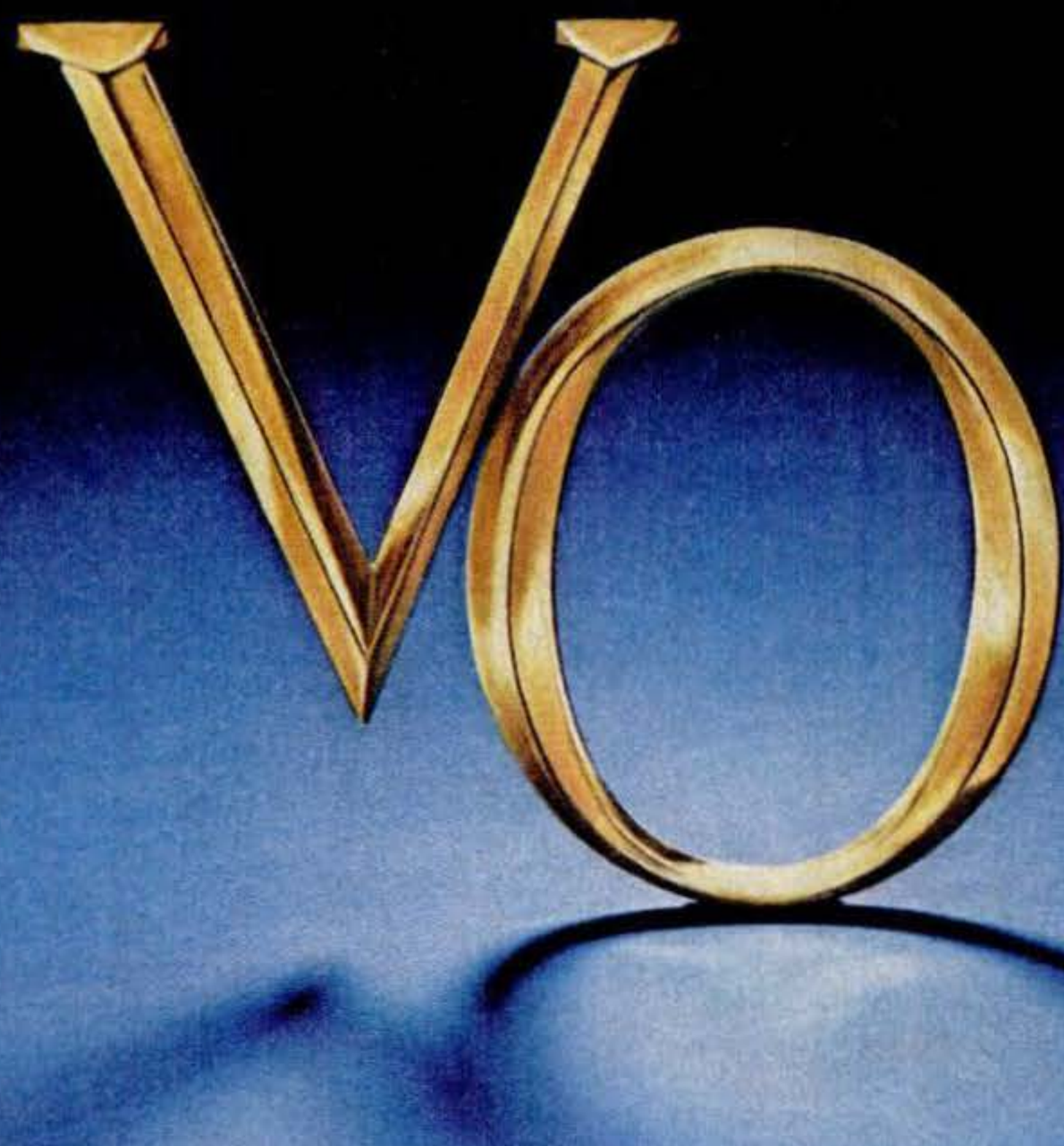
Impress friends and influence people.



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Personal luxury coupes

—posh, midsize cars with flair

PS ratings—test report in a nutshell

The ratings are based on test results and measurements. Results should be read with the understanding that they reflect tests only on our sample cars, and that other seemingly identical cars may vary in performance. Also, weather conditions (noted in our spec table) vary from test period to test period. An excellent rating is 5 points; very good, 4; good, 3; fair, 2; poor, 1; very poor, 0.

	Grand Prix	Regal	Thunderbird	Diplomat
Fuel economy	3	3	1	2
Acceleration	5	5	3	4
Braking	4	4	4	2
Handling	5	4	3	4
Maneuverability	5	5	3	3
Ride comfort	4	4	4	4
Quietness	3	2	3	3
Roominess	4	4	4	4
Visibility	2	2	2	2
Entry/exit ease	4	4	4	4

By JIM DUNNE and RICH CEPPOS

With wasteful automobiles on the way out, even personal-luxury coupes like the Grand Prix and Thunderbird have shrunk in the past two years. Do small versions still offer the styling, plushness, quietness, soft boulevard ride, and good performance that in the past have put them a cut above ordinary family sedans?

To get the answers we tested representative models from each of the manufacturers: the Pontiac Grand Prix SJ, Buick Regal Sports

Continued

Clockwise from left front, PS test cars are the Dodge Diplomat, Pontiac Grand Prix, Ford Thunderbird, and Buick Regal.

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LIGHTS: 12 mg. "tar", 0.9 mg. nicotine av. per cigarette, FTC Report AUG. '77; LIGHT 100's: 13 mg. "tar", 1.0 mg. nicotine av. per cigarette by FTC method.

I want low tar. But taste is a must.

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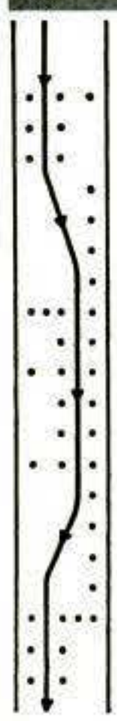

Thunderbird exits PS accident-avoidance lane-change course with high degree of body roll. Its heavy weight and soft springs make it the poorest in handling but the softest in ride. Vague-feeling Diplomat equaled the more precise Regal in this maneuver; Grand Prix was best. The test course consists of two lanes, blocked 120 feet apart. The driver must swerve left and then right at about 60-70 mph to avoid the "obstacle" in his path.

Coupe, Ford Thunderbird Town Landau, and Dodge Diplomat Medallion. There are many other cars in this class, far more than we have time to test. But much of what we say about one division's cars will hold for the rest, as all of them are based on only a few different chassis. For instance, the Regal, Grand Prix, Chevrolet Monte Carlo, and Olds Cutlass Supreme all share the same basic GM intermediate chassis, but use different sheet metal. The Diplomat and the Chrysler LeBaron are almost identical twins, and the T-Bird and Cougar share major components.

In general, all of the new cars are smaller on the outside and bigger on the inside than their predecessors. They use up less raw materials in construction and less fuel on the highway. One result of their reduced weight is that most of them handle better than the older models, but they can't match the ride and quietness of those models.

Grand Prix

The new Grand Prix is 625 pounds lighter, five inches narrower, 16 inches shorter, and its wheelbase is eight inches shorter than the old model. Yet it has almost three inches more rear leg room and almost two inches more rear hip room. It's the first Grand Prix in which all four passengers are comfortable.

The interior is still luxurious. Our test car had the optional leather seats, center console, and full instrumentation. The interior is also much more airy than in years past, a result of full-size rear-quarter windows that replace the older model's small opera windows.

The new GP is no quieter than a standard family sedan. Considering that none of the test cars is as quiet as older models but have $7700-$9100 price tags, we think they should be much quieter.

Also changed from past models is the Grand Prix's ride and handling. Like all the new GM intermediates, it rides firmer than before and its suspension is superior over rough roads. The ponderous feel and slow-motion steering of the old Grand Prix have been replaced by surprisingly quick response and nimbleness.

With less weight to haul around, the 301-cu.-in. V8 gives good performance, but its mileage doesn't live up to expectations. The older model, with the 301 V8 (and two-barrel carburetor), got 19 mpg combined city/highway driving, but the new car can only manage an uninspiring 20 mpg.

The GP also has a few small but annoying problems. The seat belts are hard to pull out and don't retract. Considerable wind noise comes in from around the door seals. At night, the instruments' brushed-chrome faces glare and reflect in the windshield, and the radio's station indicator is nearly impossible to read.

EPA fuel mileage (mpg)

	Grand Prix	Regal	Thunderbird	Diplomat
Highway	24	25	20	22
City	17	17	14	15
Combined highway/city	20	20	16	18
Calif. highway	21*	n.a.	18	19
Calif. city	14*	n.a.	12	14
Calif. combined highway/city	17*	n.a.	14	16

*305 2-bbl. V8

Regal

The Turbo Regal is one of the most important new cars to come out of Detroit in some time. The reason: its turbocharged V6 engine [PS, Sept. '77], which works so well you don't even notice it.

Around town the Turbo V6 feels a bit lazy, just like the normally aspirated 231 in the Regal. Even initial full-throttle acceleration is not much better than the regular V6. But at about 20-25 mph the turbocharger smoothly begins to take effect, and the Regal surges ahead impressively. In highway passing maneuvers the Turbo gathers itself up for a second while the turbocharger builds boost and then moves out with a swell of power. Despite the slow initial acceleration, the Turbo outhustles the Grand Prix to 60 mph by a full second—no small feat. Its only problem: detonation. But Buick says that its electronic detonation sensor protects the engine from any damage, and the noise we heard wasn't enough to be harmful. The Regal's 20 mpg combined city/highway gas mileage is no better than Buick's 305 V8. But if the performance of the Turbo were reduced to equal that of the 305 V8, it would get better mileage, Buick engineers tell us.

Most of our comments about the GP's packaging apply to the new Regal as well. Its interior is not as plush and feels smaller, due to the smaller rear quarter windows, but its dimensions are virtually the same as the GP. It also shares with the GP the problems of noise and slight door-seal leakage.

The Regal's ride is a bit firmer and better controlled than the GP's and its power steering is of the

Continued

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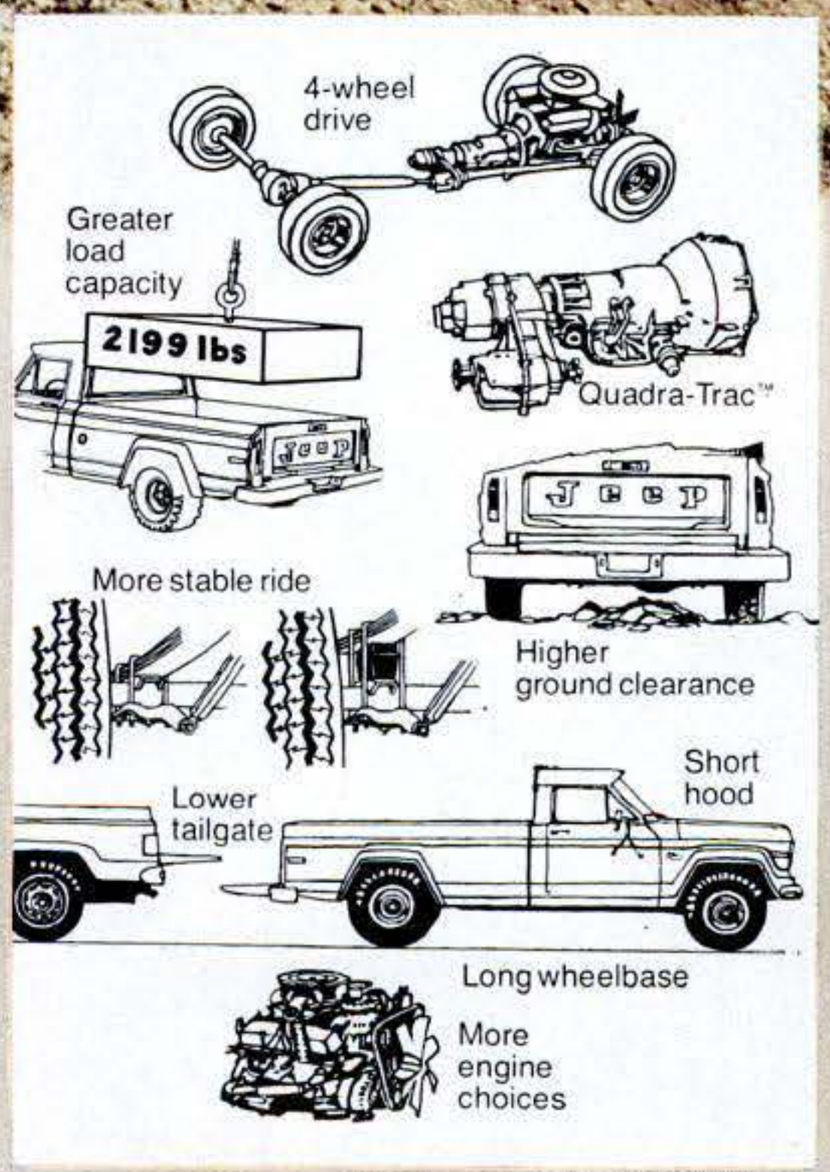
Face the facts... and you'll buy a Jeep® Pickup

There are 4-wheel drive pickups and there is the 4-wheel drive **Jeep J-10 Pickup.** If you think they're the same, you're in for an education. Jeep Pickup has **4-wheel drive that's built-in,** not added on like an option—that's the only way we make them. Jeep Pickup is the only pickup to offer optional **Quadra-Trac,**™ Jeep's exclusive automatic 4-wheel drive, the system that's unsurpassed by the competition—to give you super traction. Jeep Pickup's **load capacity** is **2199 lbs.*** That's greater than Ford, Chevy or Dodge!! Jeep Pickup has a **higher ground clearance** than all its competitors so rocks won't stop you. Jeep Pickup does not have to recalibrate its springs like the competition to gain greater ground clearance, so you get a **more stable ride** without that "on-stilts" look. Jeep Pickup has a **long wheelbase** for a smoother ride on road or off. Jeep Pickup has a **lower tailgate loading height** for convenience and a **short hood** for better visibility. Jeep Pickup has **more engine choices** than the competition. You pick the size you need. Face the facts—the 4-wheel drive **Jeep Pickup has no competition!**



*Based on available specifications, June 1977

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Jeep wrote the book on 4-wheel drive.

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high-effort variety, but its handling is no better.

While no official figures are available, Buick estimates that the turbo V6 will cost an extra $350. Taking the price premium and performance difference into consideration, the 305 V8 may be a better bargain—especially since its performance is more than adequate. Shoppers should check prices carefully before choosing the turbo V6, since its advantages over the V8 are not decisive.

Most importantly, however, the Turbo Regal reaffirms the feasibility of turbocharging, a gas-saving technology that seems to be in store for a great many more cars in the fuel-critical years ahead.

Thunderbird

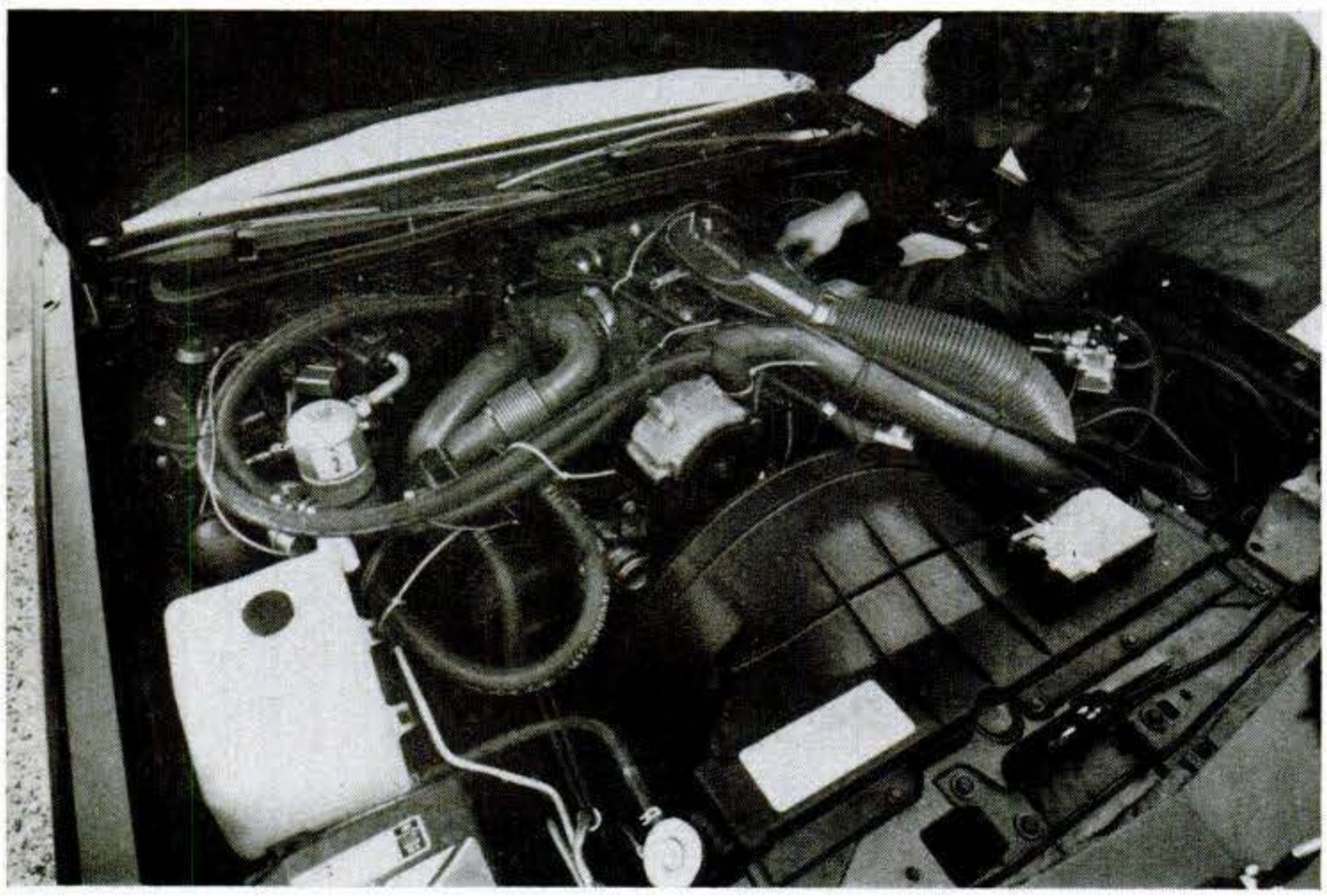
The Thunderbird was all-new and smaller for '77, but it shows just how fast things are changing: Now it's the biggest in the class. It's 14 inches longer and over 900 pounds heavier than the Regal or GP, but offers less usable interior room. In fact, rear leg room is not adequate for adults when the front seats are pushed full back. That's unforgiveable.

The interior is sumptuous, however. Our test car was done in brown brushed velour, and it was about as plush as any in this class. Unfortunately, the Bird is no quieter than the GM cars and noisier than past models.

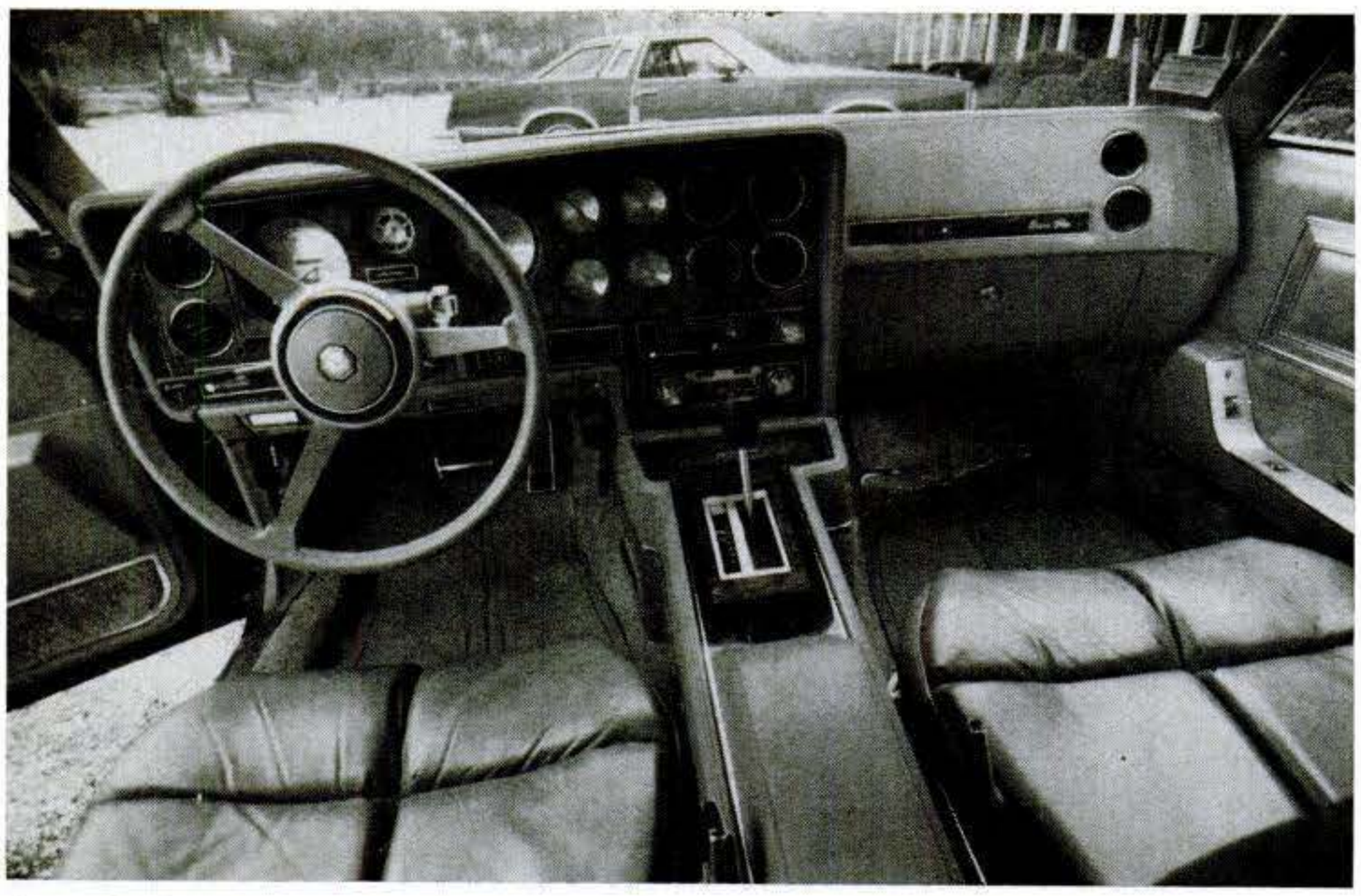
The T-Bird's hefty weight (4263 pounds) takes its toll in mileage and performance; it trailed the other test cars in both areas. The weight, along with the soft springs, hurt handling too.

The soft springs do provide a soft ride, however, right out of the old personal-luxury mold. On smooth highways the T-Bird glides along and insulates you from all manner of pavement imperfections. Over rough pavement it wallows and feels big and clumsy.

Some problems we encountered with the T-Bird were a hard-to-twist ignition switch, a confusing cruise control, an annoying electric seat-belt lock that clunks every time the door is opened, a horn bar that is hard to use, and seat-belt retractors that block entry to the rear seat.



Exhaust-driven turbocharger on Regal's 231 V6 (hidden at rear of engine) boosts power only on demand. It out-accelerates bigger V8's, gives equal mpg.



Grand Prix's interior is as posh as before, with a roomier rear seat. Busy dash includes full instrumentation. Regal's interior is not as luxurious.

Diplomat

The coupe version of the Diplomat is new for '78. It is built on the Aspen four-door chassis and shares its roof with the Chrysler LeBaron. It doesn't replace any older or larger model, but offers a smaller alternative to the Cordoba and Charger.

The Diplomat weighs about 400 pounds more than the GM coupes but 500 pounds less than the Ford. It has about as much interior room and rear leg room as the GM cars and more than the T-Bird.

The Diplomat's interior and dash layout—similar to but more luxurious than the Aspen—is about on a par with the GM cars. It was also the quietest of the four test cars, though still far from outstanding in this respect.

Aside from styling differences and upgraded interior, the Diplomat's handling and ride are little improved over the Aspen; it's only average, tending toward a vague big-car feel.

The 318 V8 just doesn't get the job done in the Diplomat, which is slower than the GM cars and only delivers 18 mpg combined. The brakes on our Diplomat were poor; severe stops made the tail end hop violently and slew sideways.

Like the LeBaron [PS, Aug. '77], the Diplomat's best feature is its price. It offers all the accoutrements of personal-luxury cars at a hefty price advantage ($1400 in this test) when fully equipped. PS

For specs and test results, turn page

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Just about everything that grows in your yard is going to look better when it's fed. And you don't have to know much about your trees, shrubs and flowers to do it right. You don't have to know much about fertilizers, either.

We have a simple word for well-fed flowers, shrubs and trees. It's "Grow."

Take flowers like marigolds and geraniums. The right fertilizer will give them the nitrogen, potassium and phosphorus they need to get you more blooms and brighter color. Ordinary soil by itself just can't come up with the nutrition to do this. It needs some help.

Here is where some people make it complicated. They tell you you have to use one thing for annuals, another for perennials and something else for roses. But that just isn't so.

Here at Scotts in Marysville, Ohio, we make one fertilizer you can use on all your flowers. And that includes seeds, seedlings and full-grown perennials. We simply call it Grow Flowers.

You don't have to use this fertilizer as often as some other brands.

While most fertilizers are made to release their nitrogen right away, we make ours to release its nitrogen slowly. Your flowers get a good feeding to start off with, then a little more week after week. This longer feeding is what helps give you more blooms on your plants and brighter color too. (You look better when you eat regularly. And so do your flowers.)

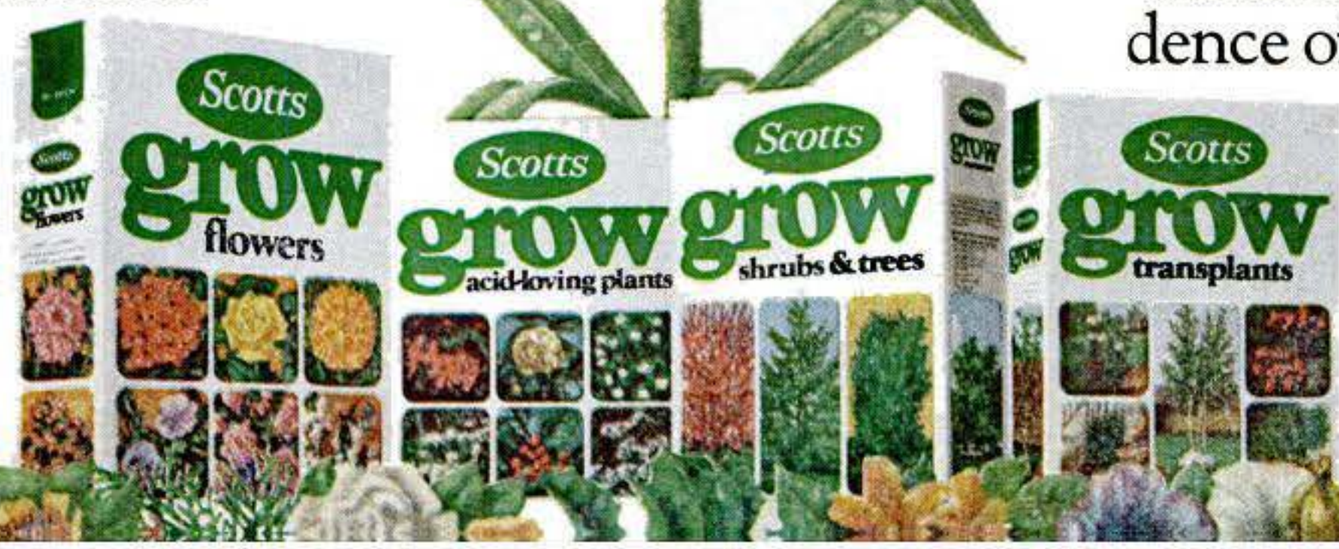
As you can see from the boxes below, we also have some simple ways to take care of your shrubs and trees, acid-loving plants and transplants. The nutritional ingredients in each of these are in correct proportion to their use. (Flowers need more of one thing, trees more of another.)

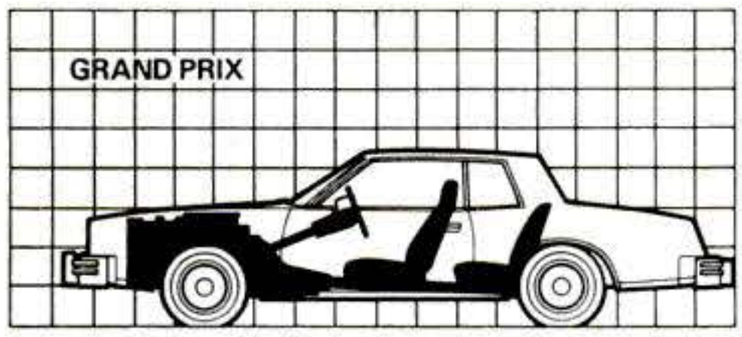
They're all safe to use if you just do what it says on the package. Like every fertilizer we make, each one has our special slow-release formula for a balanced, prolonged feeding and slow even growth.

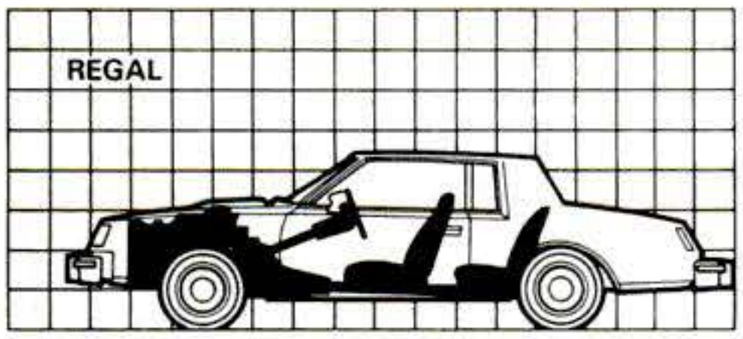
We tested all these fertilizers ourselves so we know just what they can do. They will give you healthy looking plants and better growth and that's a promise.

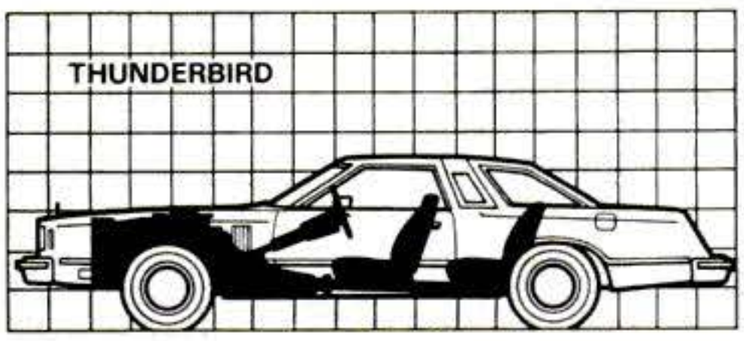
You'll find our guarantee right there on every box. It says, "If for any reason you are not satisfied with results after using this product, you are entitled to get your money back. Simply send us evidence of purchase and we will mail you a refund check promptly."

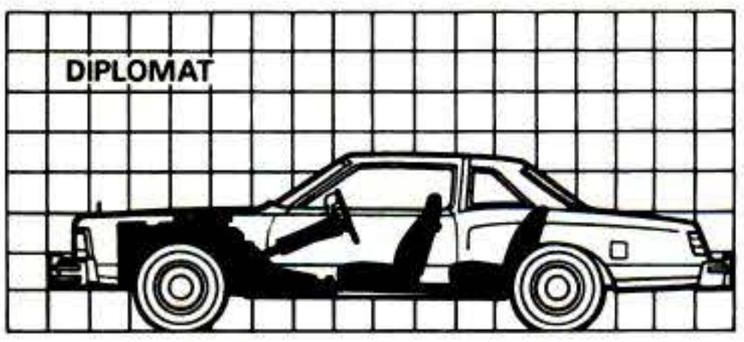
We made that simple too.











Regal and Grand Prix get the most interior room from the smallest bodies. In traffic they feel compact-sized; big T-Bird feels as bulky as a full-sized car.

PS serviceability ratings

How easy is it to service our test cars? To give you an approximation of how easy (or difficult) it is to perform various key service operations, we examine each test vehicle. The numbers mean: 1, very difficult; 2, difficult; 3, average degree of difficulty; 4, easy; 5, very easy.

	Grand Prix	Regal	Thunderbird	Diplomat
Checking fluid levels:				
Battery	5	5	4	4
Master cylinder	3	4	3	3
Windshield washer	5	5	5	5
Engine oil	3	3	3	4
Coolant	5	5	4	5
Checking engine:				
Spark plugs	2	2	4	5
Distributor	3	3	3	4
Carb adjustment	3	2	3	3
Oil filter	3	3	3	4
Oil fill	4	1	4	3
Replacing hoses:				
Top radiator hose	5	1	4	3
Lower radiator hose	5	4	4	3
Heater hoses	2	2	2	2
Changing bulbs:				
Headlights	5	5	4	3
Taillights	2	2	4	2
Front running lights	2	2	3	2
Front parking lights	2	2	3	2
Front directionals	2	2	3	2
Rear directionals	2	2	4	2
Rear running lights	2	2	3	2
Checking fuses	2	2	3	4
Spare-tire accessibility	2	3	3	3
Changing belts	3	3	3	4

Grand Prix, Regal, Thunderbird, and Diplomat—specs, dimensions, and test results

	PONTIAC Grand Prix	BUICK Regal	FORD Thunderbird	DODGE Diplomat
DIMENSIONS (inches)				
Wheelbase	108.1	108.1	114.0	112.7
Overall length	201.2	199.6	215.5	204.1
Overall height	53.3	53.4	53.0	53.3
Overall width	72.8	72.2	78.5	73.5
Track, F/R	58.5/57.8	58.5/57.8	63.2/63.1	60.0/58.5
Ground clearance	5.5	5.5	5.2	4.9
Front head room	37.6	37.9	37.3	37.5
Front hip room	51.6	51.6	55.6	55.6
Front leg room	42.8	42.6	42.1	42.5
Rear head room	37.8	38.1	36.2	36.2
Rear hip room	54.5	54.5	57.2	52.8
Rear leg room (min.)	36.3	36.4	32.6	34.0
Min. rear knee room	2.1	1.9	−0.8	−0.5
Couple distance	32.2	31.7	30.5	32
SPECIFICATIONS				
Engine type	V8	Turbocharged V6	V8	V8
Displacement (cu. in./L)	301/5.0	231/3.8	351/5.7	318/5.2
Compression ratio	8.2:1	8.0:1	8.3:1	8.5:1
Carburetion	4 bbl.	4 bbl.	2 bbl.	2 bbl.
Net hp @ rpm	150 @ 4000	165 @ 4000	143 @ 3200	140 @ 4000
Net torque @ rpm	240 @ 2000	265 @ 2800	257 @ 1700	245 @ 1600
Transmission	3-speed automatic	3-speed automatic	3-speed automatic	3-speed automatic
Axle ratio	2.41:1	2.73:1	2.50:1	2.94:1
Tire make	Uniroyal	Uniroyal	Firestone	Goodyear
Tire type	Steel-belted radial	Steel-belted radial	Steel-belted radial	Polyglas II radial
Tire size	P205/70 R-14	P205/70 R-14	HR 78-15	FR 78-15
Steering	Power (recirc. ball)	Power (recirc. ball)	Power (recirc. ball)	Power (recirc. ball)
Overall steering ratio	15.3:1	16.4:1	21.9:1	18.7:1
Turns, lock to lock	3.6	3.64	3.99	3.5
Turn diameter (ft.)	38	38	43.1	40.7
Front suspension	Independent SLA type with coil springs, stabilizer bar	Independent; A-frames with ball joints, coil springs, stabilizer bar	Independent with ball joints, drag struts, coil springs, stabilizer bar	Independent lateral, nonparallel control arms with transverse torsion bars, stabilizer bar
Rear suspension	4-link pivoted control arms, coil springs, stabilizer bar	4-link, coil springs, control arms, stabilizer bar	4-link, rubber-insulated coil springs, stabilizer bar	Hotchkiss drive, semi-elliptical leaf springs
Brakes	Power; disk drum	Power; disk drum	Power; disk drum	Power; disk drum
Brake swept area (sq. in.)	307.7	312.7	367.9	355.24
Fuel tank (gal.)	18.1	17.5	21.0	19.5
Trunk space (cu. ft.)	16.1	16.5	15.6	16.3
Liftover height (in.)	16.7	16.7	28.0	24.2
Curb weight (lbs.)	3318	3298	4263	3693
Maximum trailer size (lbs.)	4000	1000	2000	4000
F/R weight distribution (%)	56/44	56/44	57/43	55/45
Basic price	$6087	$5854	$8420	$5361
Price as tested	$8969	$8180	$9123	$7733
Major options on test car	Leather interior trim ($305), Rally RTS handling pkg. ($108), air conditioning ($544), cruise control ($90), rear defogger ($92), tachometer ($65), tinted glass ($67), power driver's seat ($151), power windows ($124), AM/FM stereo/CB ($571)	4-bbl. turbocharged engine ($50), electric windows ($124), tinted glass ($62), air conditioning ($544), AM/FM stereo radio ($236), power antenna ($45), power door locks ($80), chrome wheels ($141), two-tone paint ($175), cruise control ($90)	351 V8 ($157), cruise control ($104), CB radio ($295), rear defroster ($93)	Basic option group includes landau roof, undercoating, air conditioning, whitewall tires, tinted glass ($1054), AM/FM stereo radio ($156), power windows ($129), speed control ($94), 318 V8 ($221), vanity mirror ($48), rear defogger ($90), clock ($50), road wheels ($248)
TEST RESULTS				
Acceleration (sec.)				
0-60 mph	12.2	11.2	14.9	14.4
25-70 mph	13.0	12.2	16.8	15.2
Brake test (cool) 60-0 mph				
Stopping distance (ft.)	153	141	134	182
Pedal pressure (lbs.)	120	120	120	100
Disk temperature (°F)	130	162	125	151
Brake test (hot) 60-0 mph				
Stopping distance (ft.)	142	138	141	182
Pedal pressure (lbs.)	160	100	200+	200
Disk temperature (°F)	540	390	585	593
Interior noise @ 60 mph (dBA)	68	68	68	66
Handling test (mph)	67.1	62.4	60.0	62.4
Maneuverability (mph)	28.1	29.6	25.0	25.0

TEST CONDITIONS: Ambient temperature, 62°F; relative humidity, 70 percent; barometric pressure, 30.1 inches

Performance comparison with selected models

	1975 Ford Thunderbird V8	1975 Grand Prix V8	1977 Olds Cutlass Supreme V8	1978 Ford Fairmont 6	1978 Pontiac Phoenix V6	1978 Plymouth Volare 6
Mpg (city driving)	9.7	11.4	15.2	19.0	18.0	18.0
Acceleration 0-60 mph (sec.)	12.8	12.0	12.3	15.5	17.1	14.6
Brakes 60-0 mph (ft.)	174	158	180	155	147	165
Handling (mph)	51.3	58.2	60.0	62.4	58.2	56.3
Maneuverability (mph)	22.4	25.0	25.0	28.1	26.4	25.0
Noise @ 60 mph (dBA)	63	64	65	69	69	68

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Just check the Career Program that interests you most on the attached postpaid card. By return mail, you will receive a free career booklet with facts on the Program you have selected.

Your free booklet will also include information on employment opportunities for the career field of your choice, as reported by the U.S. Bureau of Labor Statistics in the Occupational Outlook Handbook for 1976-1977.

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In addition, you will receive a free "Demonstration Lesson" that also lets you see for yourself why getting the career training you need most may now be easier than you think.

When students enroll in these programs, their lessons and career training materials are delivered to their homes— and each lesson includes an "Open Book" exam. As the students complete their lessons, they mail back each exam for review. Correct answers are checked off, and students are told how to correct their wrong answers. Then the graded papers are returned to the students by mail. This kind of "Open Book" testing— which allows you to concentrate on learning instead of worrying about grades— has proven so successful for adults it is now used in *many* colleges.

In short, your free "Demonstration Lesson" will allow you to see for yourself why graduates report that they enjoyed independent study for these three reasons: the freedom to learn at your own pace, in the privacy of your own home; the convenience of choosing your own study hours; and the opportunity to move ahead a step at a time, lesson after lesson, until you have earned the College Degree, Career Diploma, or Career Certificate that you may need at this time to help you qualify for the job you want.

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The Center for Degree Studies is Accredited by the Commission on Higher Education for the Middle States Association of Colleges and Schools— and authorized by the Department of Education for the Commonwealth of Pennsylvania to award College Degrees that afford you recognition as an Associate in Specialized Business or Technology. You are eligible for enrollment in the Center— no matter which City or State you now reside in— if you have a High School Diploma or Equivalent.

ICS is an Accredited Member of the National Home Study Council, and authorized to provide career training leading to Career Diplomas and Career Certificates. Thus, while it's not possible for ICS or any other reputable college or school to guarantee jobs to its graduates— and employment opportunities differ from company to company and city to city— you will get the same high quality of training that ICS has been noted for since 1890. So students can enroll with confidence in ICS, secure in the knowledge that ICS is here to help them prepare for the career field of their choice— no matter which Career Program they select . . . regardless of past experience.

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When you receive your free career booklet and free "Demonstration Lesson" in the mail, you may want to show them to your employer. Please feel free to do so. You may also want to advise your employer that the ICS Industrial Training Division has special training programs and relationships with more than 3,000 companies, unions, and government agencies across the country— including corporations like Union Carbide, International Paper, 3M, Bethlehem Steel, U.S. Steel, etc. And note that if you decide to enroll in the Career Program of your choice— if you wish, your employer will be kept informed of your progress— so that your employer can better evaluate your effort and ambition should you be in line for a better job, or an increase in salary, etc.

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In short, the attached postpaid card offers 36 Career Programs designed to help you qualify for the job you want. And you can find out what the Career Program of your choice can do for you— with no obligation to buy anything now or ever.

So just take a moment to check your Career Program. Fill in your name and address. And mail the card today.

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THROUGH THE VIEWFINDER

By EVERETT H. ORTNER

Help for color printers

Can color printing be made easy enough so that anyone who likes darkroom work can produce successful color prints? Yes, says Kodak, which would like to sell you (for $20) its new Ektacolor FilterFinder kit. Black-and-white workers who switch to color printing face two major hurdles that are usually new to them. The first is the need for ultra-precise temperature control—a mechanical problem that with patience and care can be overcome. The second is the selection of color filters for the enlarger, a problem that has generally required experience and judgment that some amateurs reach only at a considerable cost of wasted paper and chemicals.

The FilterFinder system takes much of the pain out of judging correct color filtration. Its heart is a dye-transfer transparency consisting of cyan, magenta, and yellow filter squares of different values. You use this to make a test print, placing it over the image of a standard 18 percent gray card that you shot in the course of exposing a roll of film.

From that one test print you can judge accurately the color filtration you need and the exact exposure time. The kit includes the FilterFinder transparency, a "locator" to help you judge print density, a test card, and an enlarger calculator dial.

Faster tintypes

Yesterday's instant photograph was the tintype—the rich, wonderfully detailed picture that Victorians were familiar with and that street photographers were taking until World War II. Now Rockland Colloid Corp. (302 Piermont Ave., Piermont, N.Y. 10968) has brought 'em back in a kit—the Tintype Parlor. It consists of five four-by-five tintype (actually aluminum) plates. Using scissors under a darkroom safelight or red bulb, you cut the tintype to fit your camera. (Robert Cone of Rockland recommends that you use an old camera, as the metal plates can scratch the film guides. An old box camera is fine.) There is no negative. The kit comes with a monobath developer/fixer, and processing takes only three minutes. The Tintype Parlor is available in stores for $10.95 or direct from Rockland.

Snapshots

● Paul Wahl, who has written a number of articles on photography for *Popular Science*, wants to know: "Will jungle green replace professional black?" Paul was referring to a statement issued recently by Leitz, maker of Leica cameras: "Many naturalists, hunters, and animal photographers reject chrome-trimmed cameras because the unavoidable reflections startle wild animals. But they are not alone: Many other photographers have also said that they would prefer a camera with an inconspicuous or fashionable color scheme . . .

"The Ernst Leitz Wetzlar GmbH decided to satisfy this group's wishes, and has now introduced a Leica R3 and the compact binoculars Trinovid C in the new color 'jungle green.' This new combination of perfect engineering and extravagant appearance . . . is certain to find many friends."

● From England comes a new color-processing system called Photocolor II. It works on Kodak and Fuji negative-color films and Kodak Ektacolor 74RC paper. It involves only two solutions, which come ready-mixed. You add water from the tap, and you're off: two minutes for developing, ¾ minute for rinse, one minute to fix, two minutes to wash. Martin Hershenson, whose Studio Chrome in New York processes *Popular Science* color film, says it's terrific. "Kodak really has something to worry about here," says Marty. Photocolor II is distributed in the U.S. by Satter Inc., 4100 Dahlia St., Denver, Colo. 80207.

● You can now get 16-by-24-inch color enlargements made by Kodak from either 35mm slides or negatives. For $33.95—the list price—your print is mounted and comes in a choice of finishes: silk, glossy, or matte. The prints are made in Rochester, N.Y.

Super 8 handful

Just big enough to wrap itself around a super 8 cartridge, the Chinon Pocket-8 is claimed by its Japanese maker to

be the smallest movie camera in the world. I can believe it. At 5½ by 3½ by 1½ inches, the little camera slips easily into a coat pocket or, when you want to shoot, rests comfortably on the hand. The Chinon people have packed a lot of advanced features into its 15.9 ounces: a 15mm f/1.6 lens, through-the-lens viewing, automatic exposure (but with manual override), and red LED over- and under-exposure warnings in the viewfinder. Besides that, some handy accessories are available: a 4:1 (8 to 32mm) zoom lens with screw mount, a 10mm wide-angle converter, and a 21mm tele converter. Price? $149.95 for the camera, $79.95 for the zoom accessory, and $24 each for the converters. PS

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Why should you spend $3.95 for a can of motor oil?

Because it's Mobil 1 synthetic motor oil. It's better than conventional oil no matter how you drive.

It's a whole new lubrication generation: A unique multiviscosity fluid made with synthesized hydrocarbons from a patented Mobil process.

It can work magic for your engine. Here are six reasons why.

Better engine protection. For up to 25,000 miles.

Mobil 1 protects valve trains, gears, piston rings and cylinders better than ordinary oils for up to 25,000 miles, or one year, whichever comes first. It's a performance reserve you can count on.

We put Mobil 1 through a grueling United States Auto Club sponsored test for 25,000 miles, adding oil as needed. And after 25,000 miles, the Mobil 1 was tested and was found to be in such good condition, that it could be used again.

Of course, new car owners should follow warranty requirements.

Better high-temperature performance.

If you drive fast and hard, you'll find Mobil 1 won't thicken and form deposits to the extent ordinary oil does.

We proved it in the Olds 111C "SE" high-temperature-high-load test (3000 rpm, 100 HP, 300° F oil). Ordinary oils are tested for only 64 hours. But we had to double the test length to get even a significant viscosity increase with Mobil 1.

Faster cold starts.

Down where even antifreeze turns to mush, Mobil 1 helps your engine start quickly. Ordinary oils are so thick at −20° F we can't measure their viscosity. Mobil 1 still flows at −50° F.

Cleaner intake system.

Because it's so stable, Mobil 1 forms less deposits on intake area and valves.

a cyclic test on a 6-cylinder, 250-cu.-in. Chevy engine, Mobil 1 gave 78% less buildup on intake valves than conventional oil, after 200 hours of testing.

A cleaner engine.

A lot of people say it. We can prove it. Our exclusive detergent additive package is why. Even after 384 hours—double the standard length—in the Ford VC test, Mobil 1 came up better than ordinary oil standards in every way. Less sludge and varnish. No oil ring or screen clogging. No ring sticking.

Better mileage

You can get more miles per gallon, too. Up to 10 miles per tankful for the average car. (Some test cars got as much as 27 more miles per tankful.) Sure, you know a million ways to boost your mileage; here's a way to get a little bit more.

That's the Mobil 1 story. And now you know why it's worth up to $3.95. Or even more.

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The oil that does it all

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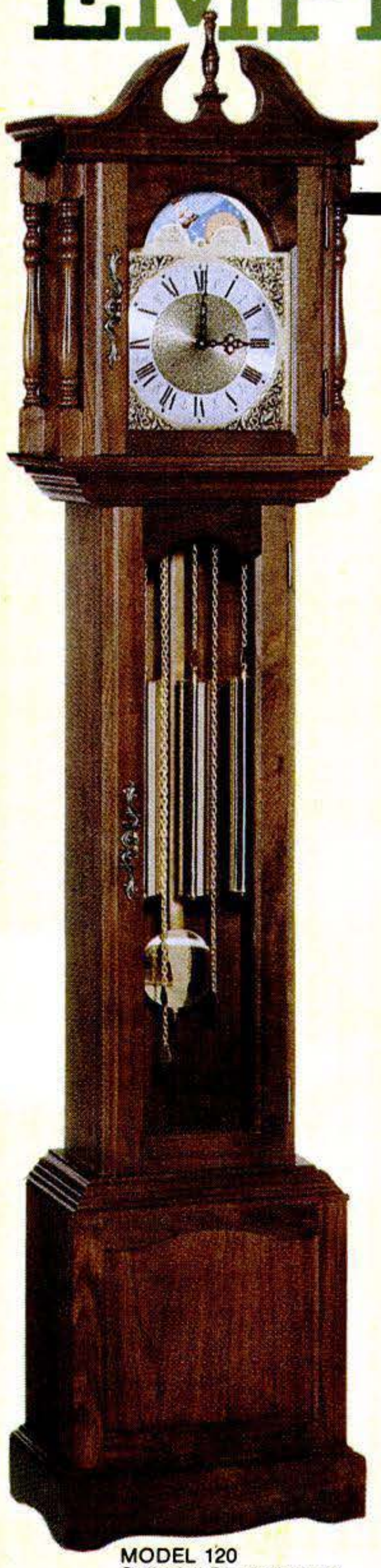

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SOLID 3/4" BLACK WALNUT

104.50 FACTORY DIRECT SALE PRICE

When purchased with movement (extra). Or, case kit alone $114.50. Reg. Factory Direct $149.50
COMPARE YOUR FINISHED CLOCK WITH THOSE RETAILING UP TO $850

THE LEADER AND NUMBER ONE

EMPEROR CLOCK COMPANY revolutionized the grandfather clock industry by selling high quality merchandise direct to consumers at low, low prices. Imitators have tried to copy Emperor, but Emperor remains the LEADER and NUMBER ONE everywhere. Why? Because of quality and price. Emperor has the quality because we cut all of our own kits to our exacting standards in our own plant. We do not resell kits made by others. *We* do the work ourselves and then pass along our factory efficiencies to you in lower prices. BEST QUALITY. LOWEST PRICE. *No wonder Emperor sells more kits than everyone else put together!*

PRE-CUT READY TO BUILD

Building a grandfather clock is easy starting with an Emperor kit. All kit pieces are accurately pre-cut from kiln-dried solid ¾" black walnut . . . a highly prized furniture hardwood which is exceptionally strong and takes a rich luster when finished. All pieces are sanded smooth on both sides. All miters, mortises and tenons pre-cut at no extra charge. (For those who prefer, kits may be ordered unmitered.) Divided swan neck, waist and dial face doors, dial frame and base-front are pre-assembled. Complete, easy to read instructions included. No woodworking experience or special tools necessary. Each piece may be reordered separately.

EMPEROR CLOCK COMPANY
WORLD'S LARGEST MANUFACTURER OF GRANDFATHER CLOCKS

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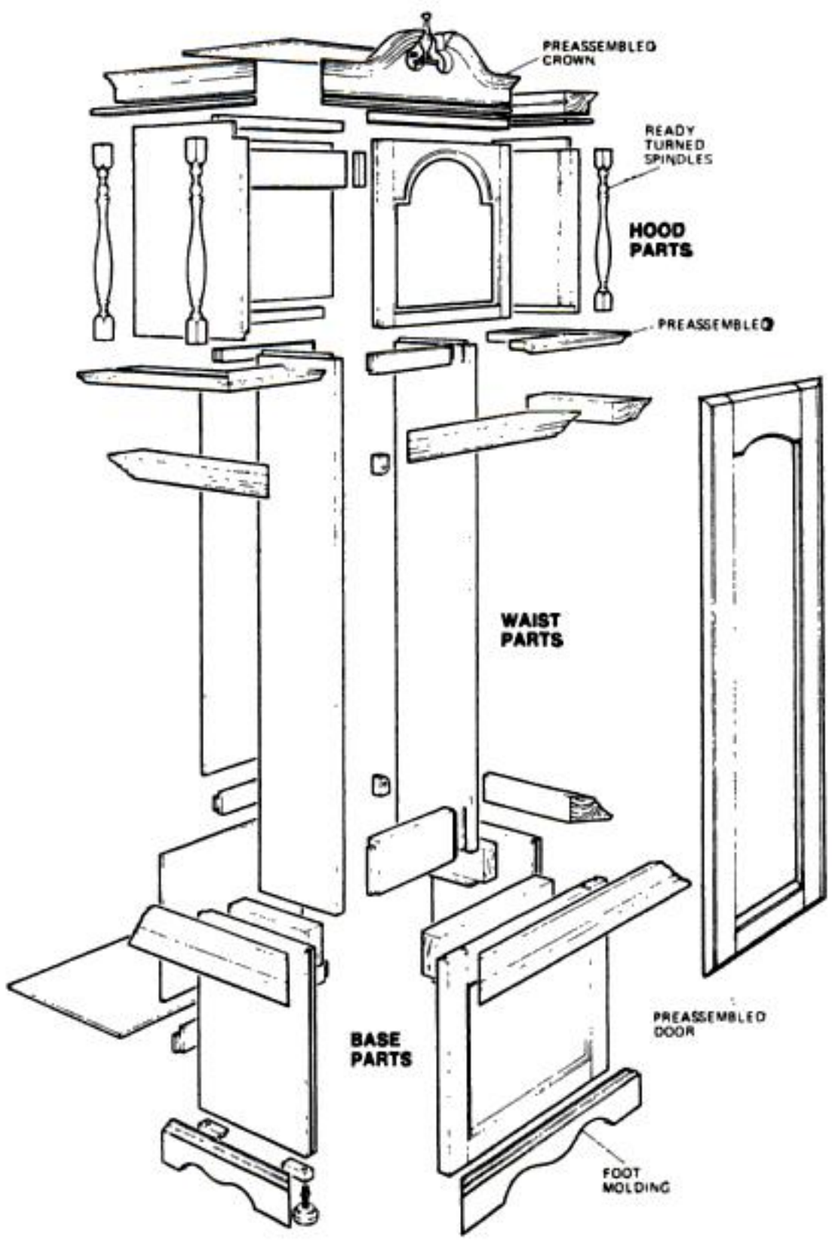
EMPEROR MOVEMENTS AND DIALS FOR MODEL 120-K



PRECISION-MADE SOLID BRASS MOVEMENTS
Emperor Model 100-M movements are manufactured in West Germany by a fourth generation of clocksmiths. Precision-made to our exacting specifications, they are made of highest quality heavy-gauge solid brass with hardened steel pinions. Movements include weights, solid brass weight shells, brass bob, pendulum and chimes.

The chimes consist of two sets of musically-tuned rods. One set sounds the historic Westminster chimes: four notes on the quarter-hour, eight on the half-hour, twelve on the three-quarter-hour and sixteen on the hour. The other set counts each hour with a Big Ben tone.

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Emperor 100-M movement dials are also manufactured in West Germany by a firm famous for their beautiful craftsmanship. Emperor quality insists that all dial faces be solid heavy-gauge brass. Emperor does not sell dial faces made of steel or aluminum, then coated to look like brass.

Choose from two dial versions: Tempus Fugit (Time Flies) and Moving Moon with classic lunar calendar. Both dial faces are solid brass. The dial ring is also solid brass with a silver finish and black Roman numerals. Antiqued brass spandrels frame the dial ring and the center inlay is texture-finished brass.

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Because each 100-M movement and dial face bears the Emperor name, all movements are thoroughly inspected and tested in our quality control room before being shipped to you. We proudly stand behind our name 100%. Emperor movements and dials are known and valued everywhere for lasting accuracy and dependability. Don't risk buying anything less.

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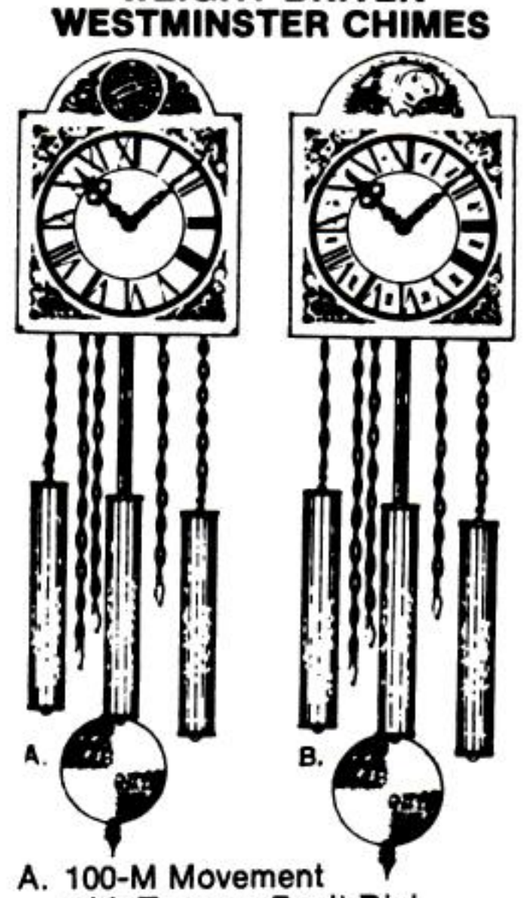

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	Model 120-A Solid ¾" Black Walnut Completely Finished Clock with Tempus Fugit Dial, Westminster Chimes	95	$454.50		
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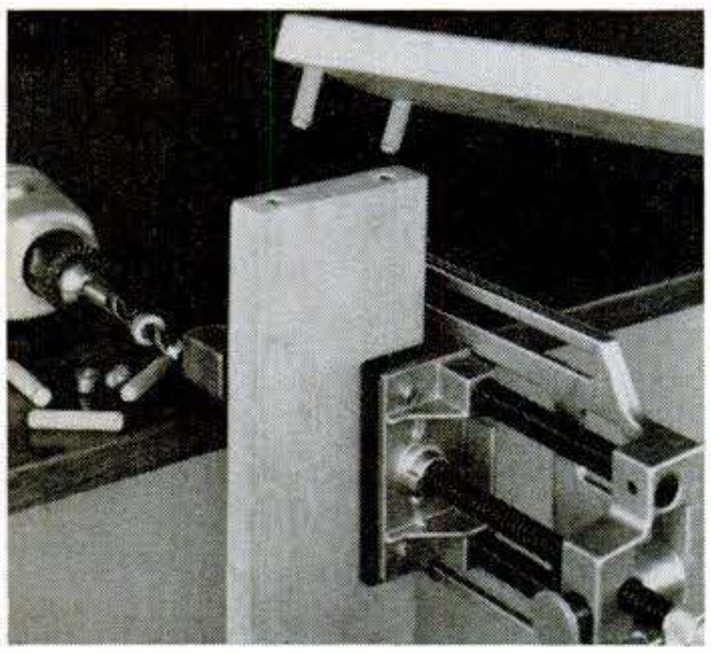

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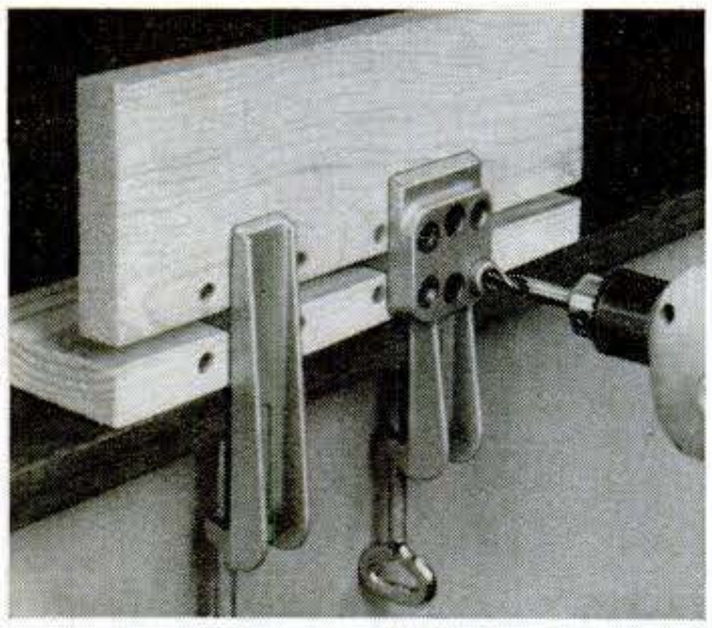

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Questions gas quality

Will using gas sold by independent stations (at prices three to six cents a gallon less) cause problems like carbon buildup or excessive valve wear as compared to gas sold by regulars such as Standard, Texaco, Shell, etc.?

R.H. Guthoff, Bloomington, Ill.

The basic answer is: Hell no, since most of the independents' fuel comes from the major refineries anyway. The biggest disadvantage is that a lot of the cut-rate fuel is out of season; the majors' summer fuel may end up at the independents' stations in fall and early winter. For this reason, starting and flooding problems are more likely to appear. Gasoline is very touchy about temperature and you really need as many fuel blends as there are seasons. Of course, some of the cut-rates should be avoided because they do have low-quality fuel, but you'll notice it quickly in poor performance.

What cures noisy lifters?

A mechanic I consider to be reputable says that the hydraulic valve lifters on my 1970 Buick LeSabre cannot be adjusted. The lifters clatter loudly at both idle and higher rpm. The car has an otherwise great-running 350, four-barrel V8 with air, automatic, and 81,000 miles on the clock. What can be done about this annoying problem?

Ronnie Cormier, Freeport, Tex.

Your best bet is to replace them all with new lifters. You can clean the old ones, but it ends up as a bad investment because the cost is just as high. I'd suggest you drop the oil pan and clean it out, and then have a mechanic okay the oil pressure to the lifter gallery. If you find a lifter with the bottom chewed up, look at the cam lobe under it; the cam will be gone, too.

Burns out clutches

I have a 1976 Buick Skyhawk V6 with five-speed transmission. It now has 27,000 miles and is on its fifth clutch. The last one lasted the longest—about 12,000 miles—probably because most of my driving is on the parkway commuting 100 miles per day, with a minimum of shifting. Do you have suggestions as to what should be checked? This seems to be a problem with these cars and Buick has no answers.

George L. Clegg, Poughkeepsie, N.Y.

A small engine with low torque, a very high rear-axle ratio, and a small clutch don't go well together. You're having to slip clutch a lot to get it going. The cheapest fix is to get a clutch with ceramic facing and a pressure plate to go with it. The next best choice is to put in a lower-ratio ring and pinion.

Truck tires increase mpg?

It is common knowledge that at higher tire-inflation levels gasoline savings are greater, but inflating tires too much results in increased wear, which can cancel the savings on gasoline.

Because all passenger-car tires known to me have a maximum operating pressure of approximately 32 psi, I cannot increase my tire pressure enough to get as big a savings on gasoline as I want. But truck tires are used at 70 to 120 psi without abnormal wear. Would it be justified from the point of view of economy to use truck tires on my car, and at what approximate pressure, taking into consideration reasonable safety requirements? Harshness of ride does not bother me because 99 percent of my driving is on well-paved roads. But what would 100-psi tires do to ball joints, shock absorbers, etc.?

A.I. Kvashin, Oakland, Calif.

There's no simple answer to your questions. Different conditions make it impossible to design a perfect tire for everybody. The ideal tire for mileage is very hard, smooth, and narrow, but it won't stop, start, corner, or ride very well. The best wet-weather tires are not the best for dry weather, and so on. A radial of the narrowest possible size that still provides good traction when run at maximum recommended pressure is best all-around for you. Very high tire pressures, as you suspect, would eat your mileage savings in a hurry due to accelerated suspension and body wear. Lastly, although tires will definitely contribute to mileage, they are hardly the biggest factor. Other things that could help more are reduction in car weight and size, the use of turbochargers, and a much higher operating temp.

Solving V6 knock

I have a '77 Olds Cutlass with a 231 V6. I've been having a problem with a spark knock occurring at three-fourths to full throttle (especially at lower rpm). I've checked and rechecked timing following the procedure on the emission sticker under the hood. If you retard the timing to, say, 6°, the knock will stop. Is this knock due to the small engine and the heavy weight of this car? I also feel that the turbo-hydromatic is geared way too high for

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this engine. Is it something I'll have to live with or can it be corrected?

A.L. Smeland, Hayes, Va.

Change to a fuel with higher octane, say 90 or more (no-lead), and redo the advance curve in the distributor by shortening it up at the low end (that's a job for experts). Lastly, you can drop the rear-axle ratio or tire size if possible. These last two are easier than changing the transmission ratios.

Gas-mileage improvers

I own a '76 Cordoba with the 400-c.i.d. high-performance engine (4-bbl. carb, dual exhaust). This engine is used on Chrysler's pursuit cars and can burn any kind of gasoline (it has no catalytic converter). The only rear-axle ratio available with this option was 3.21:1. My feeling was that, considering the price differential between regular and no-lead gas, my cost/mile would be about the same as with the catalytic-equipped engine—so I thought I had a "better" engine.

After 5000 miles for a good break-in, I changed to Key oil in the crankcase, Key transmission fluid, and Key gear lube in the differential, and adjusted the engine as recommended by Key oil. Prior to the change my gas mileage ranged from 8.8 to 13.1 mpg, with the low figure occurring during stop-and-go driving and the high figure occurring during interstate driving. Since the change, the range has been 9.4 to 13.1. I have concluded that there was improvement in mileage (but not seven percent as indicated by the low figures) attributable to Key oil.

In February '76 the Chrysler Lean Burn system became available. After inspecting an installation and some performance data, I was convinced that it was a desirable system and could be retrofitted onto my engine. Then I found out that it would cost $400-plus in parts.

I've also considered an Offenhauser Dual Port 360 inlet manifold. All of these thoughts are directed toward improving mileage within emission-control limits, with no sacrifice in performance.

What is your opinion of these systems and the practicality of installing them on my engine?

Hugh A. Barnwell, Los Angeles, Calif.

From the letters I'm getting on Lean Burn, put an ad in the paper anywhere and offer to swap your ignition for Lean Burn. I think you'll get 200 or more for free. On the intake-manifold change—forget it. That's a game for car buffs with time, tools, and excess funds.

Each month in *Popular Science* Smokey Yunick answers questions on cars—family cars, high-performance jobs, hot rods, and racing cars—selected from those sent in by readers. Got a problem? Send it to: "Say, Smokey—," Popular Science, 380 Madison Ave., New York 10017. Questions cannot be answered by mail.

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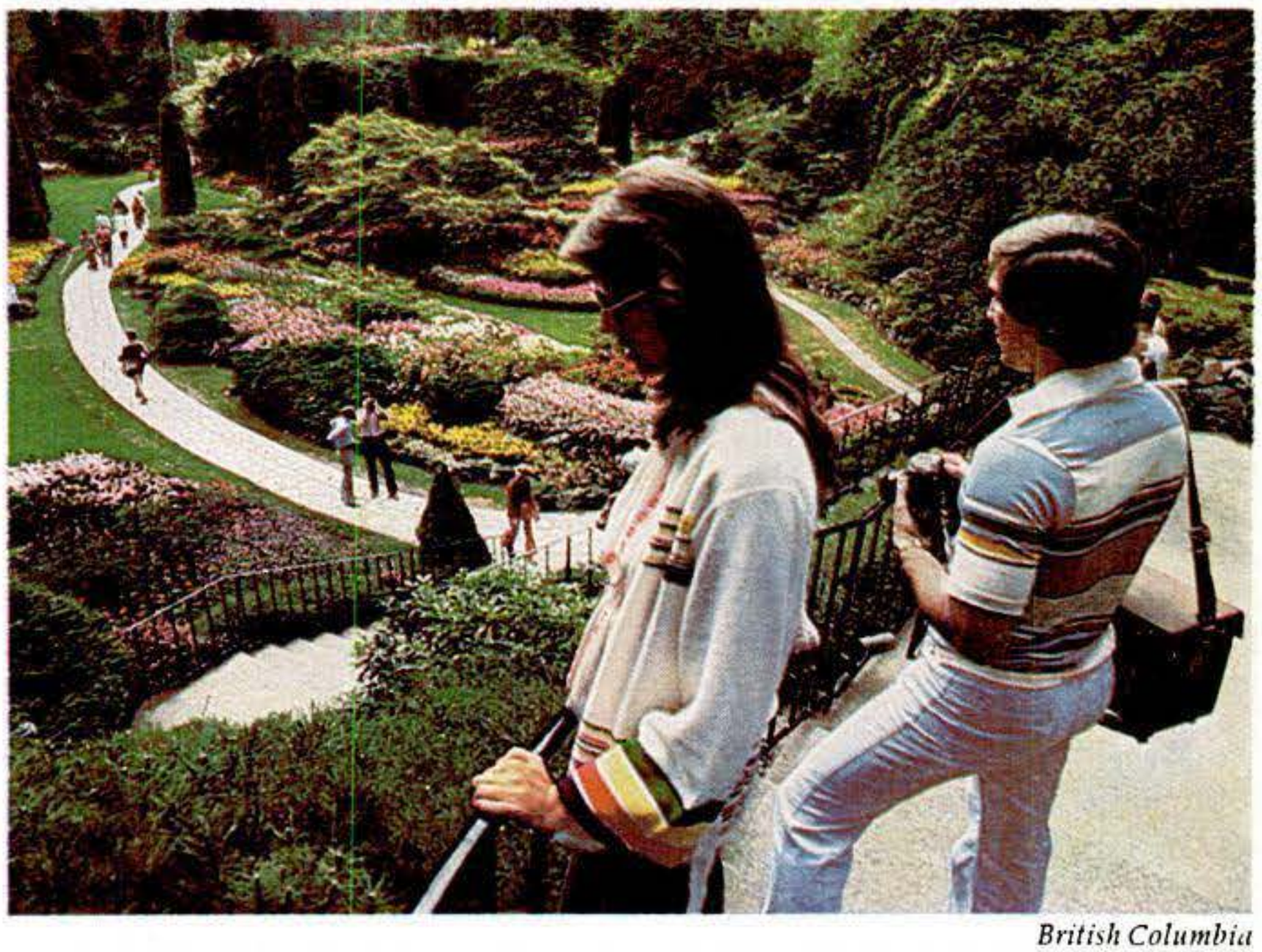

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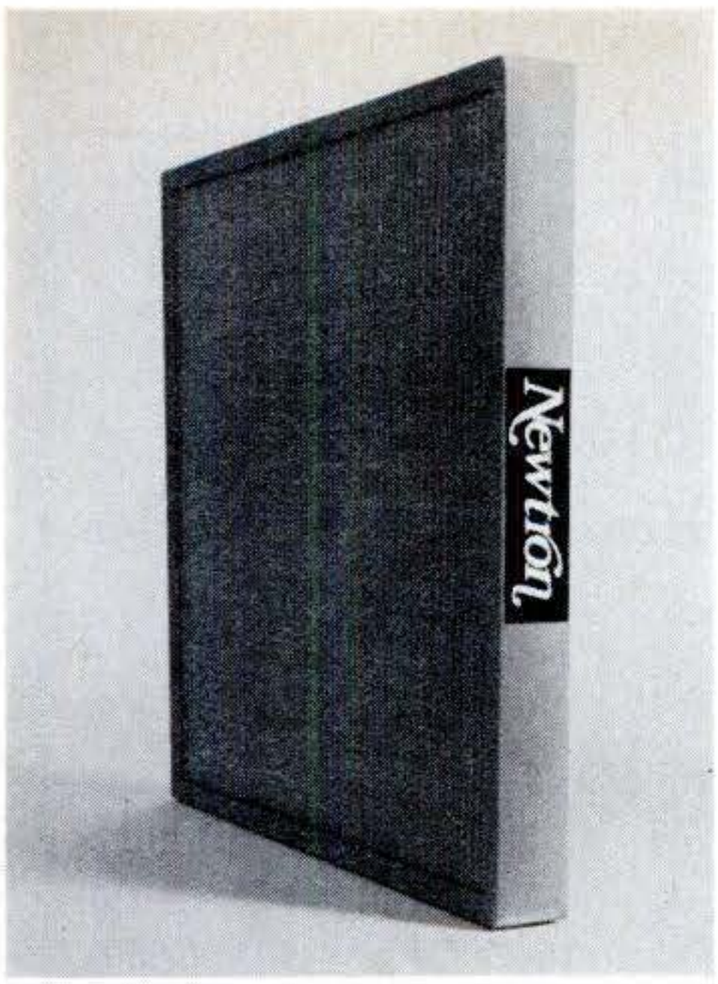


Air-powered **dust filter**

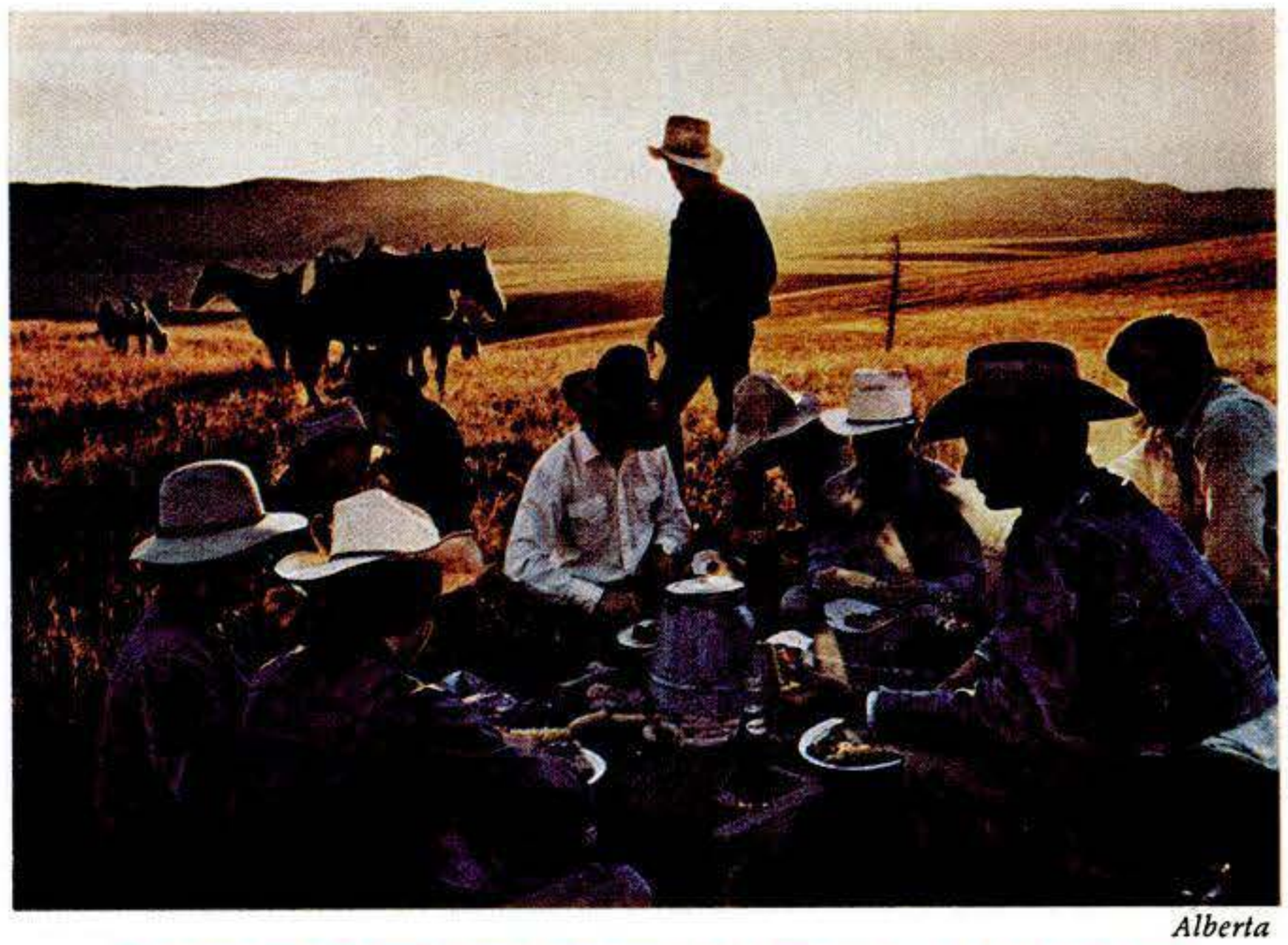
If you want clean indoor air but find filter prices prohibitive, the Newtron air-powered filter may help. You install it yourself in any size forced-air furnace or air conditioner. The filter removes dust, pollen, and other pollutants with nearly twice the efficiency of electronic filters, says Newtron Products (Box 18112, Greenhills, Cincinnati, Ohio 45218). Yet the Newtron costs $189, while electronic filters run from $500 to $1000, not counting installation and operating costs.

Like electronic filters, the Newtron attracts dust electrostatically, but it uses moving air instead of electricity to generate a charge. Inside the two-inch-thick filter, a polyurethane pad is centered between two rows of hollow acrylic rods that are surrounded by mats woven of polypropylene. Airflow through the filter produces positive charge on the rods and pad. Airborne debris picks up the mats' negative charge and is then caught by the rods and pad. Newtron says the filter is 98 percent efficient and can catch particles as small as half a micron in diameter.

"I live on a dusty back-country road," Newtron's Jay Leatherwood told me. "We have a dark mahogany table which had to be dusted daily. With the new filter, we have to dust it only once a week."

The Newtron, with no moving parts, has a lifetime warranty. The only upkeep required is bimonthly vacuuming or hosing down. Also, you can take it with you when you move.—*Laura Wessner*

CANADA



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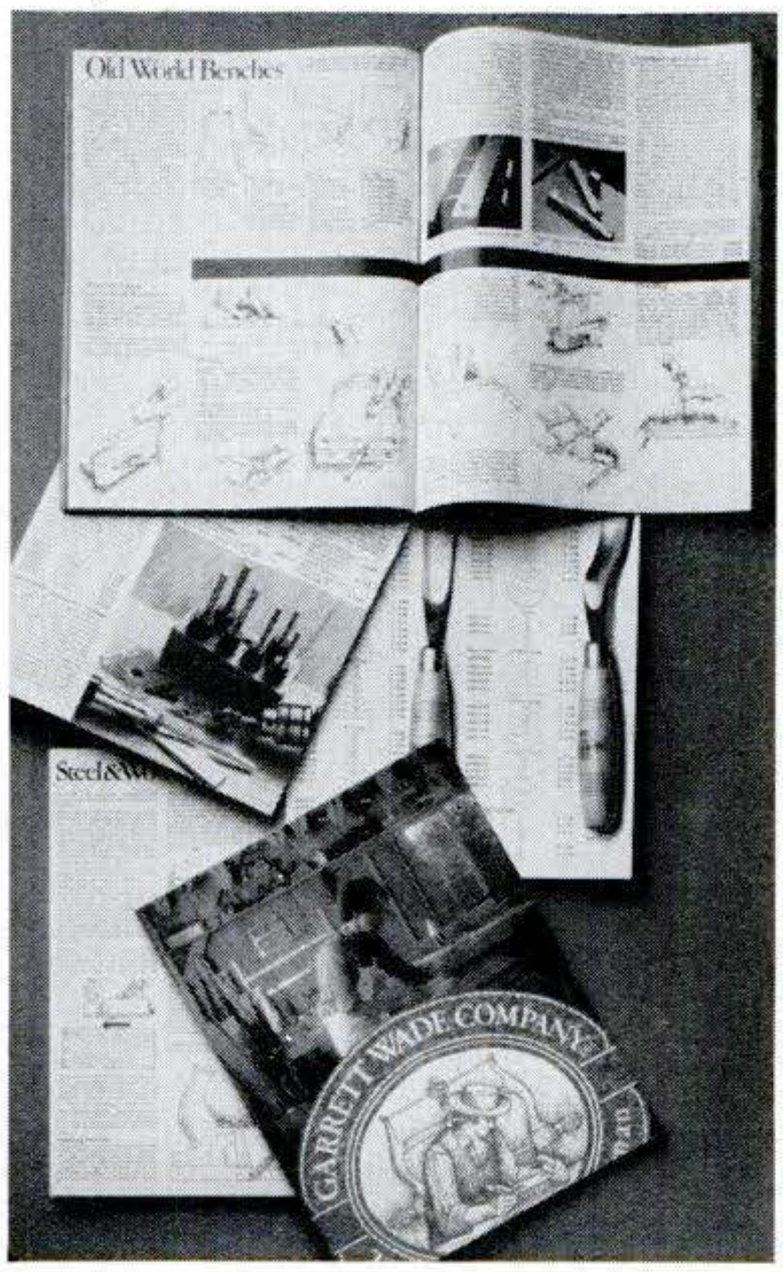

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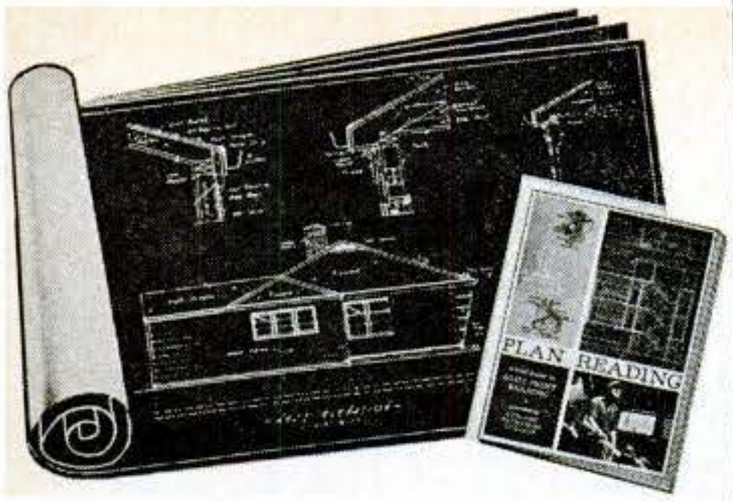

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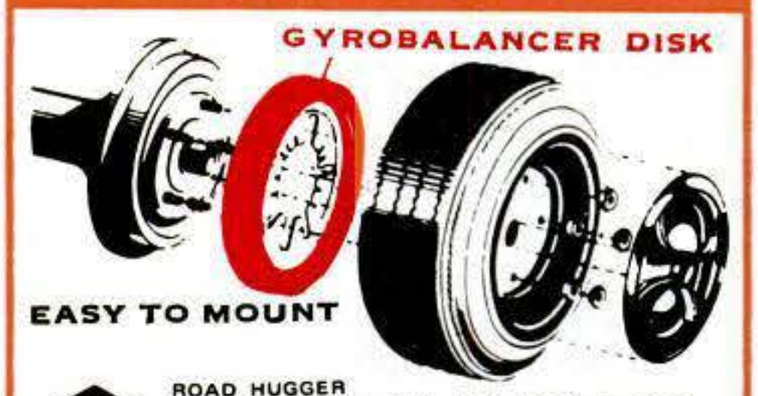

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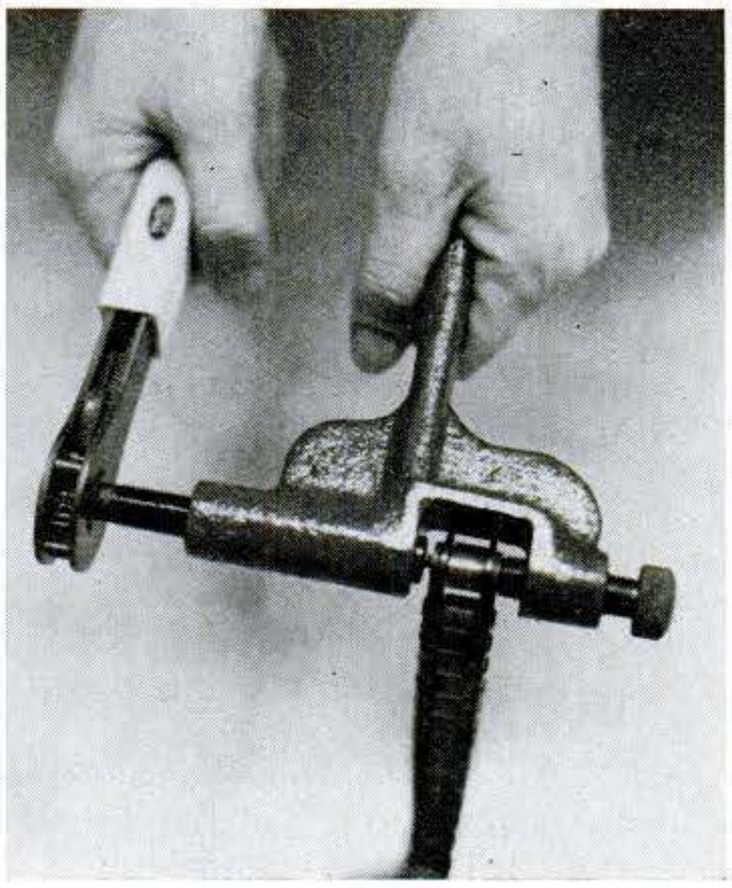
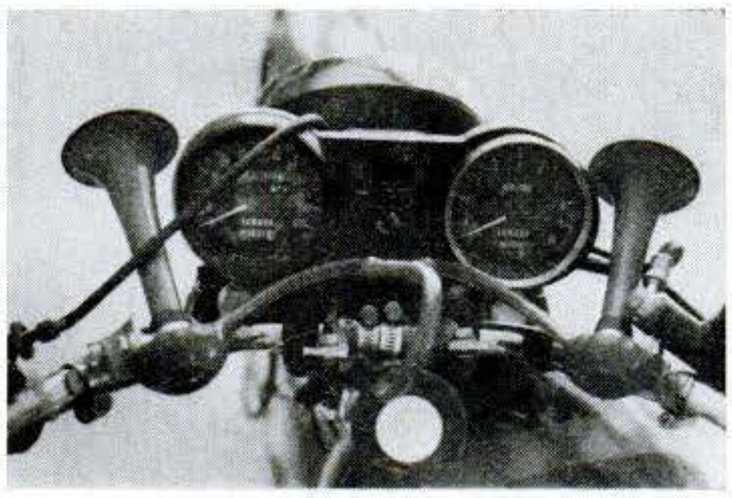


New chain breaker

This neat little chain breaker handles ½"-, ⅝"-, and ¾"-pitch chains. A ratcheting handle makes pushing the chain breaker's specially hardened punch pin down through the chain link easier and quicker. The punch pin pushes the rivet pin all the way through the chain link. A molded nylon-covered handle makes the chain breaker more comfortable to use when removing stubborn rivet pins.

All the chain breaker's parts are replaceable. While its rugged construction decreases the possibility of breakage, it's reassuring to know that you don't have to buy a new chain breaker if a failure does occur. Just replace the missing part.

The price of model No. 456 is $25.62. From Maxco, 1409 South Santa Fe Ave., Los Angeles, Calif. 90021.



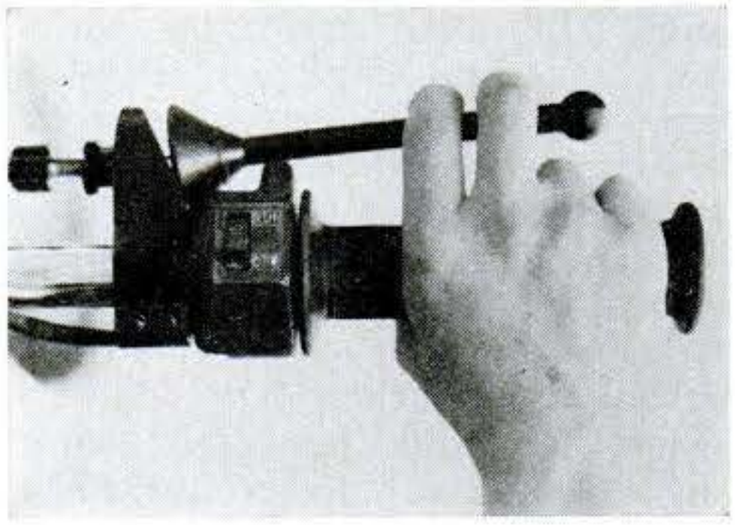
Air horns are better

We've all been angered at one time or another by unthinking, unseeing motorists who rudely cut in front of us on the road. And of course we've blown our little motorcycle horns and been further outraged at the ineffectual beep they make.

Take heart. You can wake up those rude dudes fast with these Hella air horns. For $28.50 you get two horns, an air compressor, air hose, relay and installation instructions. The biggest problem you'll have is finding a place to mount everything.

On my Yamaha RD 350 I mounted the horns and compressor on the handlebars. I fabricated some mounting brackets out of ¼" strap steel, bending as necessary in a vise. The brackets are held firmly to the bars with screw-type hose clamps. Now when I blow my horns, the right people know it.

They're sold by Racemark International, Box 82, Burnt Hills, N.Y. 12027.



Joy stick

Because trail riding inevitably leads to a spill now and then, your clutch and brake levers may get a lot of abuse. Sometimes they bend; sometimes they break. My solution to this problem: I never fall (you believe that, don't you?) and I have a set of Magura levers.

Now there's another solution on the market. It's called the Joy Stick. I tried out a couple of the levers on my 250 Can Am.

Unlike a conventional lever, which pivots at one angle around a pin, the Joy Stick pivots from any angle. And it's made of fiberglass-reinforced polycarbonate (Lexan)—which means that it's virtually unbreakable. A boot is available to cover the pivoting area to keep out dirt and mud. The boot is especially necessary in muddy conditions to keep mud from jamming the levers.

The levers work pretty well. My only real complaint is that they aren't stiff enough for my liking. Even with the front brake fully on, the lever continues to give—right on back toward the handlebar. Also, I find that the lack of a

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fixed pivot point contributes to a vague feel.

While the levers may not be stiff, the cost is: $10.95 apiece. Each boot is $1.95. From Ross-Myring Engineering, 8822 Zeiler Ave., Pacoima, Calif. 91331.

Assorted metric fasteners

A good habit to adopt is never throwing used fasteners away. Just put them in a special "junk" box, so that when you need a particular nut or bolt, you may already have it. For those of you who don't practice this old mechanic's ritual, or for those who want to augment your supply of fasteners, here's a box of assorted metric fasteners—hex-head cap screws, pan-head machine screws, matching nuts, flat and lock washers. There are 252 pieces in all. $14.95 buys them and the sturdy plastic box they come in. You can order the Metric Mechanic's Pac from Ohio Metrics, Box 22, Warren, Ohio 44482.

Wecor cruise control

A simple cruise control for your scooter can make long street rides less tiring. This one is inexpensive and can be installed in seconds. It fits over the throttle grip. A rubber O-ring placed over the end of the device provides tension on the throttle grip. To use it, you turn the throttle to the desired cruise speed, then push the cruise control against the brake lever. This stops the throttle springs from pulling the throttle closed. To close the throttle now, you must manually twist it.

It works, but I don't particularly care for the amount of force you must exert to close the throttle. Nor do I like the amount of fiddling you must do each time you reset the device. The Vanda-

Continued

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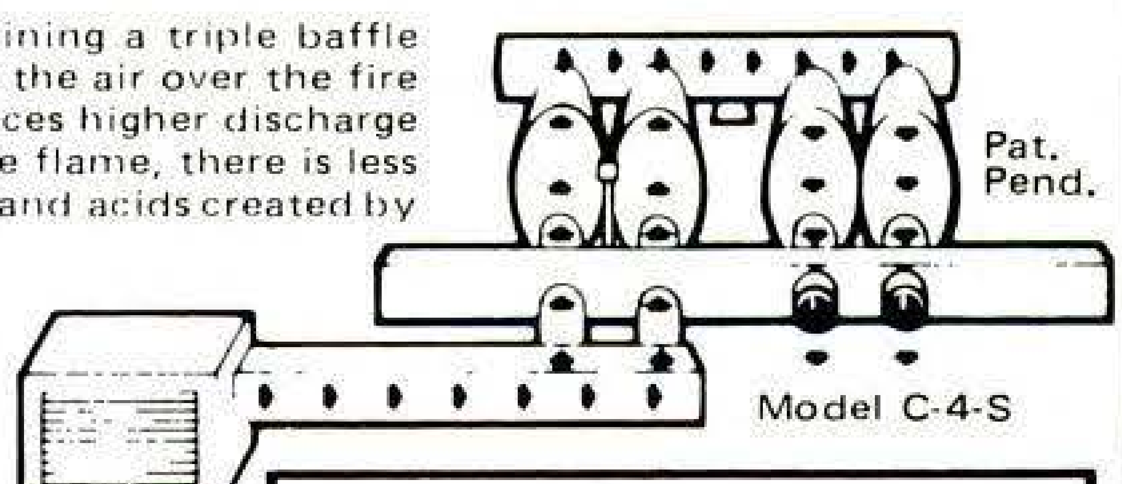

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Motorcycling

[*Continued*]

Cruise unit I reported on in February was superior to the Wecor unit in these two respects. But it was more expensive, too. This one is only $6.95; the Vanda-Cruise is $21.95.

Wecor cruise control can be purchased from Wilkinson Enterprises Corp., 308 Vine St., Roland, Iowa 50236.

Radial-ply motorcycle tire

To my knowledge, this is the first time a radial-ply motorcycle tire has ever been offered to the mass market. This one, from Avon, is the result of two years of development work. Designed for trials machines, it's a three-ply construction, with one radial ply built over a two-ply cross-ply casing. Avon says that with the new construction, extremely low pressures (as low as 2.5 psi) can be used, resulting in more tread contact with the ground. Also the tread tends to wrap itself around objects, giving greater grip.

Available in 4.00 x 18 and 3.00 x 21 sizes, it is supposed to offer the stability of a conventionally constructed tire and provide good puncture resistance. At press time prices were not available. The tires are sold through Hap Jones, 1040 Rock Ave., San Jose, Calif. 95152.

Hard-to-find racing items

If you're into road racing, you may have found that things like Lewis road-racing boots and Ferodo disk-brake pads are hard to come by. You can find these and other goodies at Racers Supply, 6959 Van Nuys Blvd., Van Nuys, Calif. 91405. A dollar brings you their new catalog. PS

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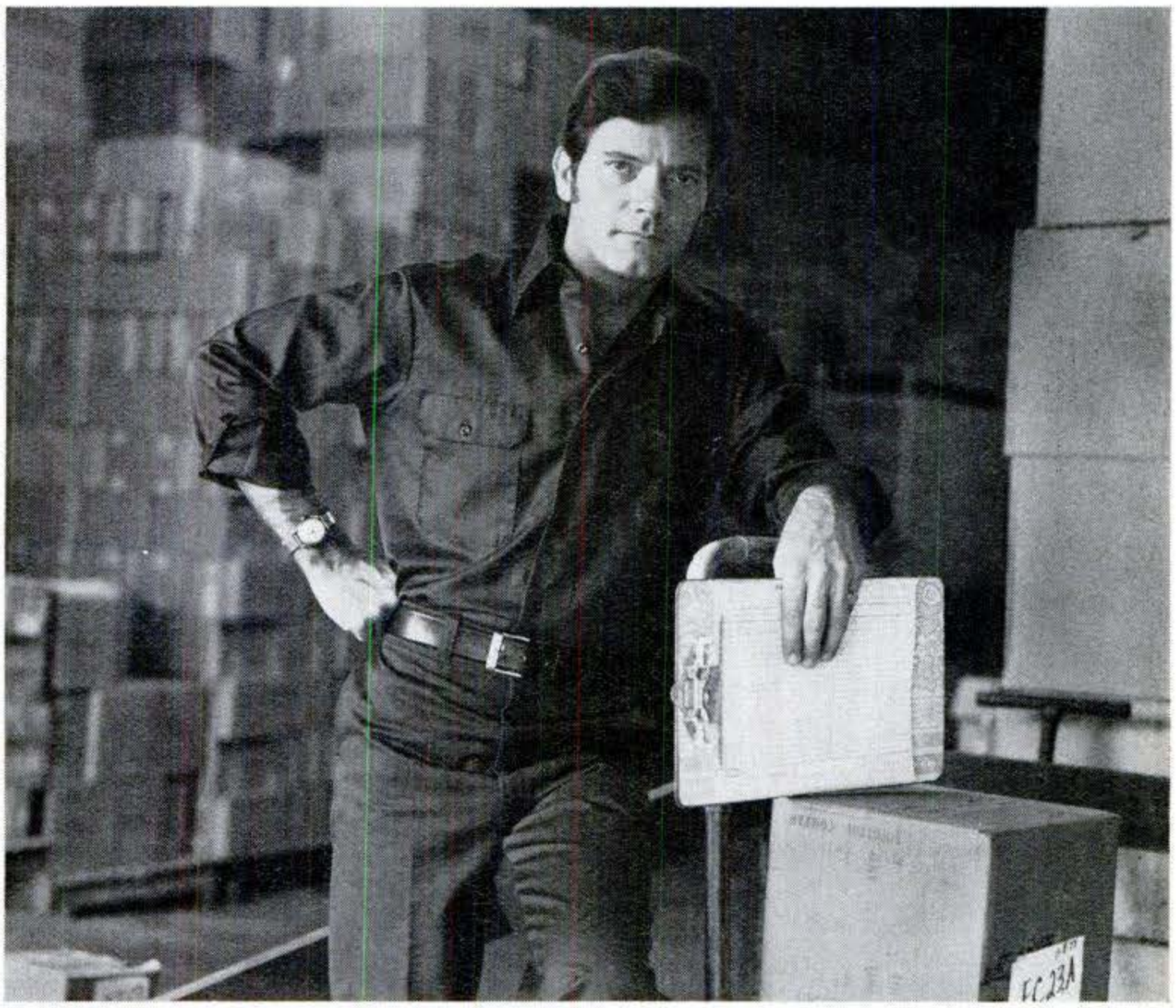

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Ovshinsky's strange devices: **Semiconductors** made from glass

A semiconductor memory material in this electron micrograph displays both amorphous or noncrystalline (top) and crystalline (bottom) structural phases. They are reversible: Amorphous changes to crystalline when exposed to energy.

A family of mysterious materials is overturning the rules of solid-state physics and may generate cheap electricity from the sun

By ED EDELSON

"Watch this," said Dave Strand, picking up what looked like a strip of silvery, exposed photographic film from a table. He put a negative over the film, gave it a brief zap of light from an ordinary flash unit—and there was an image on the film.

"Now watch this," Strand said, holding the same piece of film against a laboratory hot plate. Wherever the film touched, it changed from silver to a darker color.

I was in the offices of a company called Energy Conversion Devices in Troy, Mich., just north of Detroit, and Strand was showing me a new kind of film that can lie exposed to light indefinitely and then produce an image without benefit of a camera.

But the real story was not the film. It was the material from which the film is made and the man who made that material possible. Energy Conversion Devices is built around a family of materials called amorphous semiconductors, and it was created by Stanford R. Ovshinsky, one of the more remarkable people of our time.

"Colorful" and "controversial" are the words usually employed to describe Ovshinsky. Neither makes him happy. He says he wants to be regarded as just another face in the scientific crowd. But Stan Ovshinsky has a way of making headlines.

Just a few weeks before I inter-

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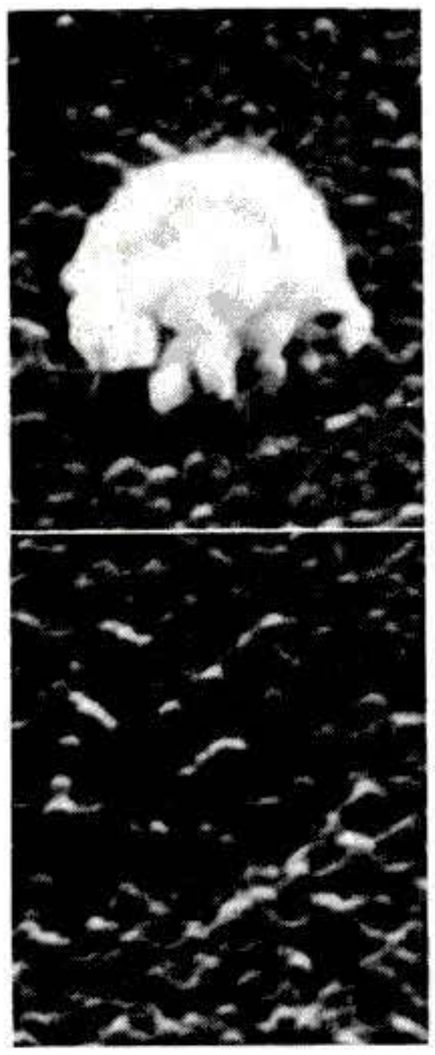

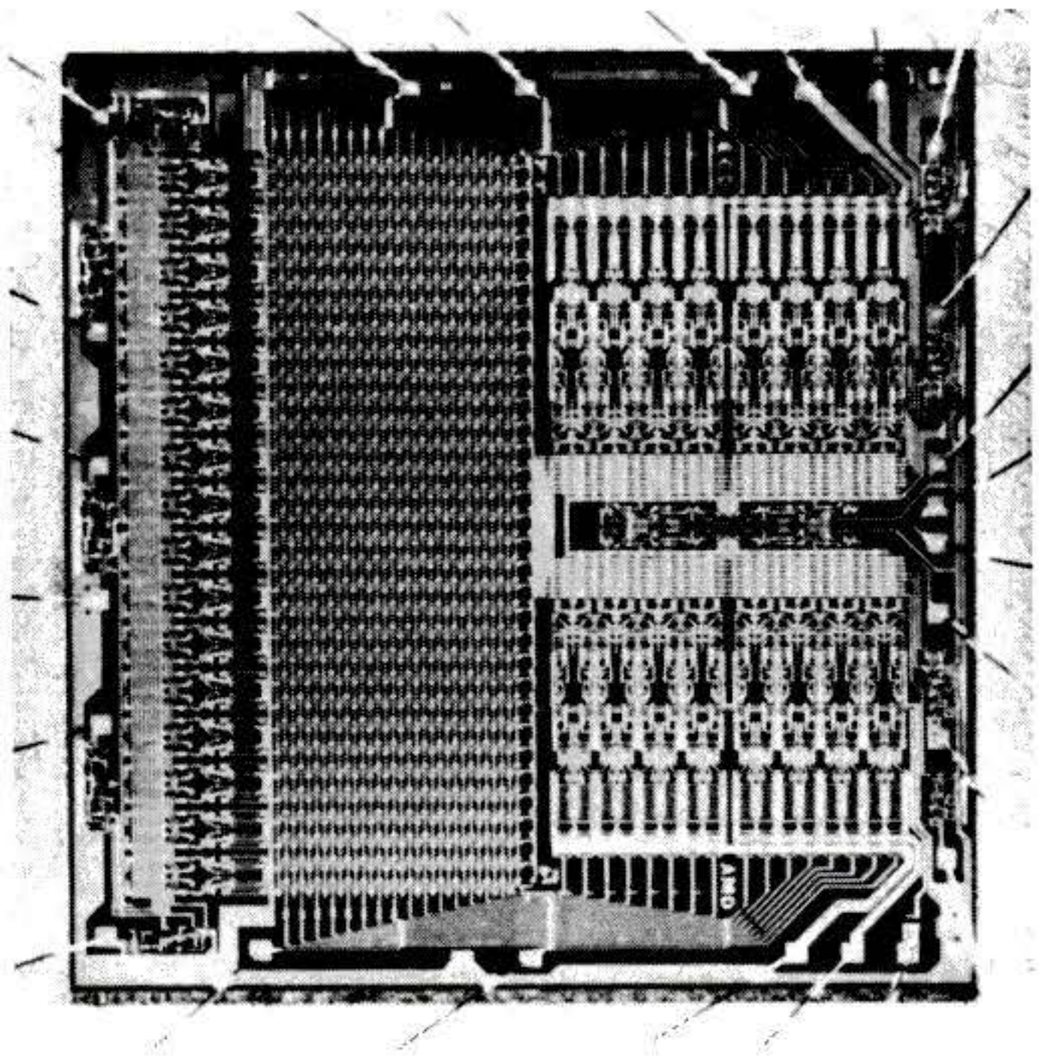

Ovonic memory chip (right), made by Burroughs Corporation, is used as an alterable memory for computers. It changes in conductivity when hit by an electronic pulse, enabling the basic characteristics of a computer to be changed simply and cheaply. The amorphous-semiconductor memory elements are massed in the wide patterned band at the left of the chip. Electron micrographs (left) show memory material in "on" (top) and "off" (bottom) states.

viewed him, for instance, he announced at a press conference (in the British House of Commons, no less) that he had created a family of materials that can make solar electricity cheaper than electricity from coal, oil, or nuclear plants. The demonstration by Dave Strand, an ECD employee, was just one of a daylong series of displays of products that Ovshinsky describes as revolutionary. And before I left, Ovshinsky told me that devices based on his material have the capability of replacing everything on which today's solid-state physics is based.

Wait, there's more. Ovshinksy is a man who never went to college and who became, in turn, a self-taught automation expert, a self-taught brain expert, and a self-taught expert in a hot new field of physics that he claims to have virtually invented. Some of the world's leading physicists believe passionately in his work; others talk about Ovshinsky in sentences that prominently feature the word "but." A single scientific paper of his set off a fight that is just dying down after a decade (and which Ovshinsky's side seems to have won).

To spend a day or two with Ovshinsky, as I did recently, is to understand why he seems to be the center of controversy. This compact, hawk-eyed, 55-year-old man with a halo of white hair has the almost hypnotic attention-drawing ability that is possessed by natural leaders. He also has the knack of saying, in the quietest way possible, things that can make his listeners sit up straight in astonishment. After listening to Ovshinsky for a few hours, you find it hard to remember that other people are doing valuable work in his field and that many experts doubt that he can change the world of electronics in the way that he claims.

And all of this fuss is about nothing but glass.

What's so special about glass? In solid-state physics, everything. On the atomic level, a glass is a sloppy, formless sort of substance, a lot of atoms bonded together in no particular pattern. But the solid-state physics that gives us the transistor radio, the pocket calculator, and the digital watch is based on rigidly ordered crystals, created under strict quality control and fashioned by recipes measured in parts per million.

So when Ovshinsky came along saying that amorphous materials—glasses—can do many things that crystalline semiconductors can do, but at a fraction of the cost in materials, there was hell to pay. In the credentials-conscious scientific world, it didn't help that the claim was being made by a man who didn't even have a college degree.

But today, things look good for Ovshinsky's side. Most of his original, hotly disputed claims have been accepted by an influential part of the physics community. Some giant corporations—Burroughs, Xerox, RCA, Fuji, Agfa—are working hard on amorphous-semiconductor research or are actually bringing products to market. And amorphous-semiconductor research was one reason why Sir Nevill Mott and Philip W. Anderson won the 1977 Nobel Prize in physics, an award which Ovshinsky—and a number of other scientists—views as a vindication of himself.

Ovshinsky's company, Energy Conversion Devices, is starting to turn his ideas into saleable products. In a fast tour of its inconspicuous group of cinder-block buildings, I was shown a new lithographic film that uses no silver and that is said to be faster, cheaper, and better than the film now used to produce magazines like this one; a revolutionary new microfilm system that will allow users to add new information to old files—something that is impossible with today's microfiche systems; a new kind of computer memory that can be either permanent or changeable, depending on your needs; and a few other wonders.

And Ovshinsky says the best is yet to come. His laboratory is working on a new kind of amorphous material that can be made cheaply by the bucketful, be sprayed in a thin film on a low-cost surface such as glass, and convert sunlight into electricity at prices rivaling or bettering those of today's oil-burning plants.

The paradox is that with products like this and intuitive theories that generally are proved sound by more detailed studies, Ovshinsky still manages to be accused of overselling. An excellent illustration is the great threshold-switching flap of 1968, whose reverberations are just dying away.

Threshold voltage switching

It started innocently enough. *Physical Review Letters*, one of the world's great scientific journals, printed a paper in which Ovshinsky said he had observed a phenom-

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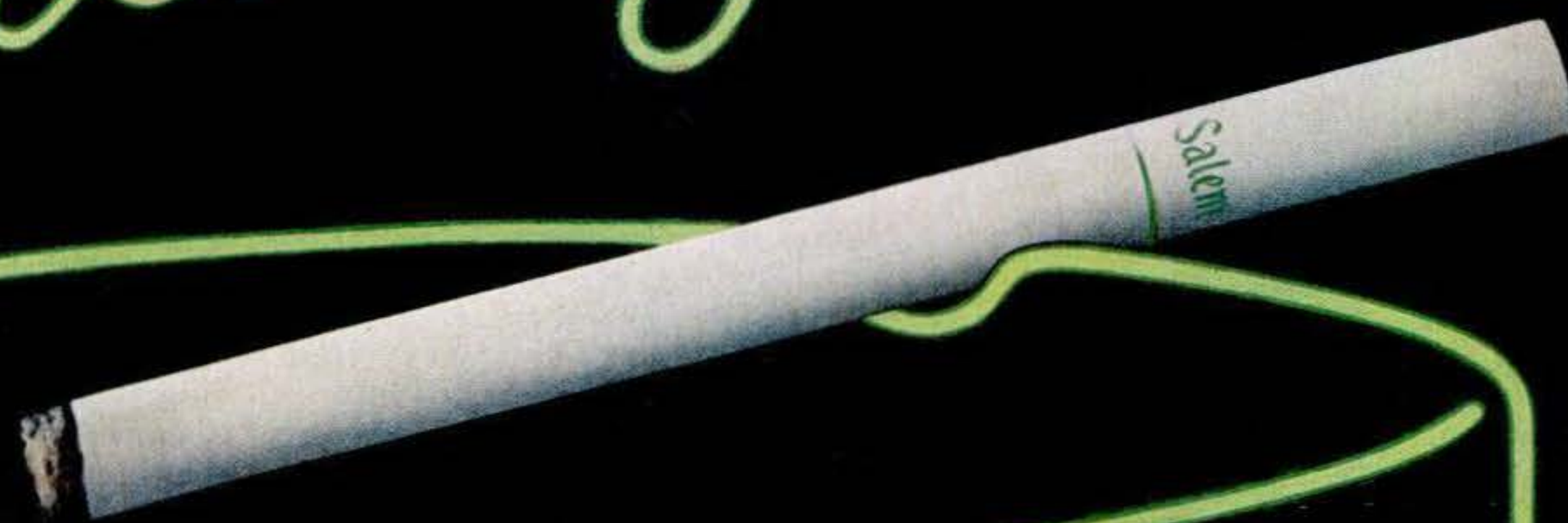

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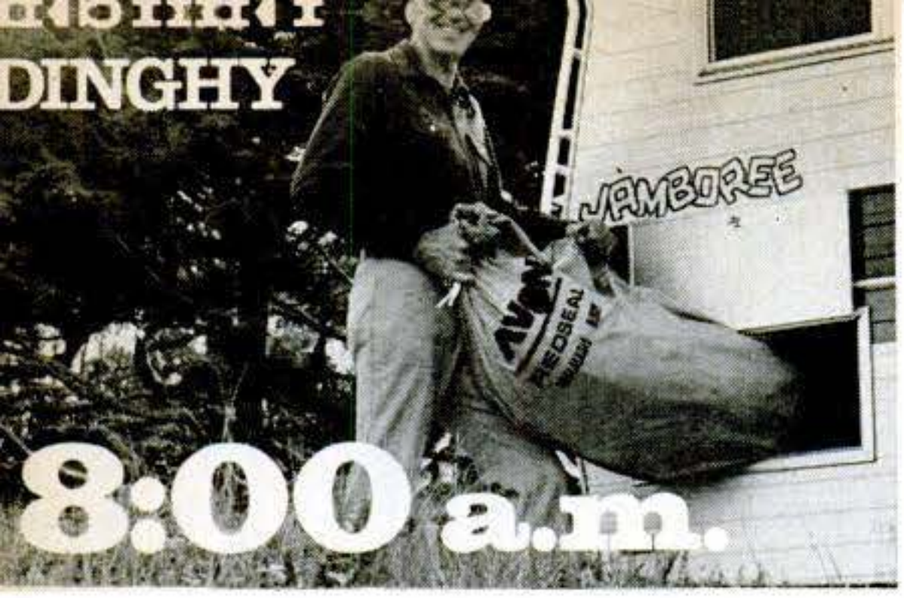

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enon called threshold switching in a class of amorphous materials called chalcogenide glasses. (The chalcogenides are elements in the fourth column of the periodic table; the chalcogenide glasses include elements from the third, fourth, and fifth columns.)

Switching, a basic phenomenon in electronics, occurs when an electric pulse above a threshold voltage changes a material from a conductor to a nonconductor, or vice versa. Ovshinsky said he had made such a switch out of a chalcogenide glass. In effect, he was saying that a cheap glass could do everything that an expensive crystal could.

Screams arose. Critics said that Ovshinsky was not giving the scientific details needed to validate his claim, that the switching phenomenon in amorphous materials was not new and—most telling—that the switching was caused by heat melting the glass, not by a rearrangement of electrons. Heat switches wear out quickly and so have limited uses, whereas electronic switches last forever. If heat was the cause, then amorphous devices could never compete with crystal semiconductors.

But as David Adler, an amorphous-semiconductor expert at the Massachusetts Institute of Technology, says of Ovshinsky's 1968 paper, "Almost every statement he made in it has now turned out to be accurate." There is mute evidence of that on a table behind Ovshinsky's desk: an amorphous switch that has been going off and on since 1969, a total of 10,000 billion cycles.

But Energy Conversion Devices got surprisingly little practical benefit out of the report. The price of the stock did go up sensationally, from almost nothing to $150 a share, but it came down almost as spectacularly. A few major corporations paid several hundred thousand dollars to explore Ovshinsky's materials, but nothing tangible emerged. ECD limped along, its debt growing to a total of almost $20 million by the mid-1970's.

Amorphous vs. crystalline

In 1968, Ovshinsky said that amorphous semiconductors could compete with crystals. Just the opposite happened. Amorphous materials appeared to languish while crystalline semiconductors entered a golden era that has given us all of today's electronic marvels.

Ovshinsky blames scientific jealousy and corporate blindness. An alternate explanation is that crystal semiconductors simply are easier to work with.

Most of today's semiconductors are based on silicon, an atom that forms four bonds with its neighbors. The first step is to make a perfect crystal of silicon. Then the material is "doped" by adding a minuscule amount of an element that forms either five or three bonds. In the crystal, these dopant atoms are forced to form four bonds. This means that there are either extra electrons or an absence of electrons—holes—that can move through the crystal. The controlled movement of these extra electrons or holes is what makes a semiconductor usable in electronics.

But now look at amorphous silicon, which has not gone through the expensive processing needed to make a perfect crystal. Because the silicon atoms are in disarray, the dopant atoms can form their normal number of bonds, three or five, which means there are no extra electrons or holes that can be used electronically.

And chalcogenide glasses seem to be an even bigger mess: a jumble of atoms such as selenium, tellurium, and arsenic that seem to be bonded together in no predictable pattern at all. Adding dopants to a chalcogenide glass seems to be like spitting in the ocean. Getting a carefully controlled flow of electrons in such a material seems impossible.

But it didn't seem that way to Ovshinsky.

The son of European immigrants who became factory workers in Akron, Ohio, Ovshinsky says, "I just wasn't interested in school." After working in several cities as a machinist, he got interested in a field that had not yet been named automation. By the mid-1940's, he had patented an automated lathe. By the early 1950's, he was research director for the Hupp Corporation, working on automation.

Brain research was the logical next step after automation, Ovshinsky says. He was working on neurophysiology at Wayne State Medical School in the 1950's; detailed drawings of brain structures line the wall outside his office. Ovshinsky saw the brain as an

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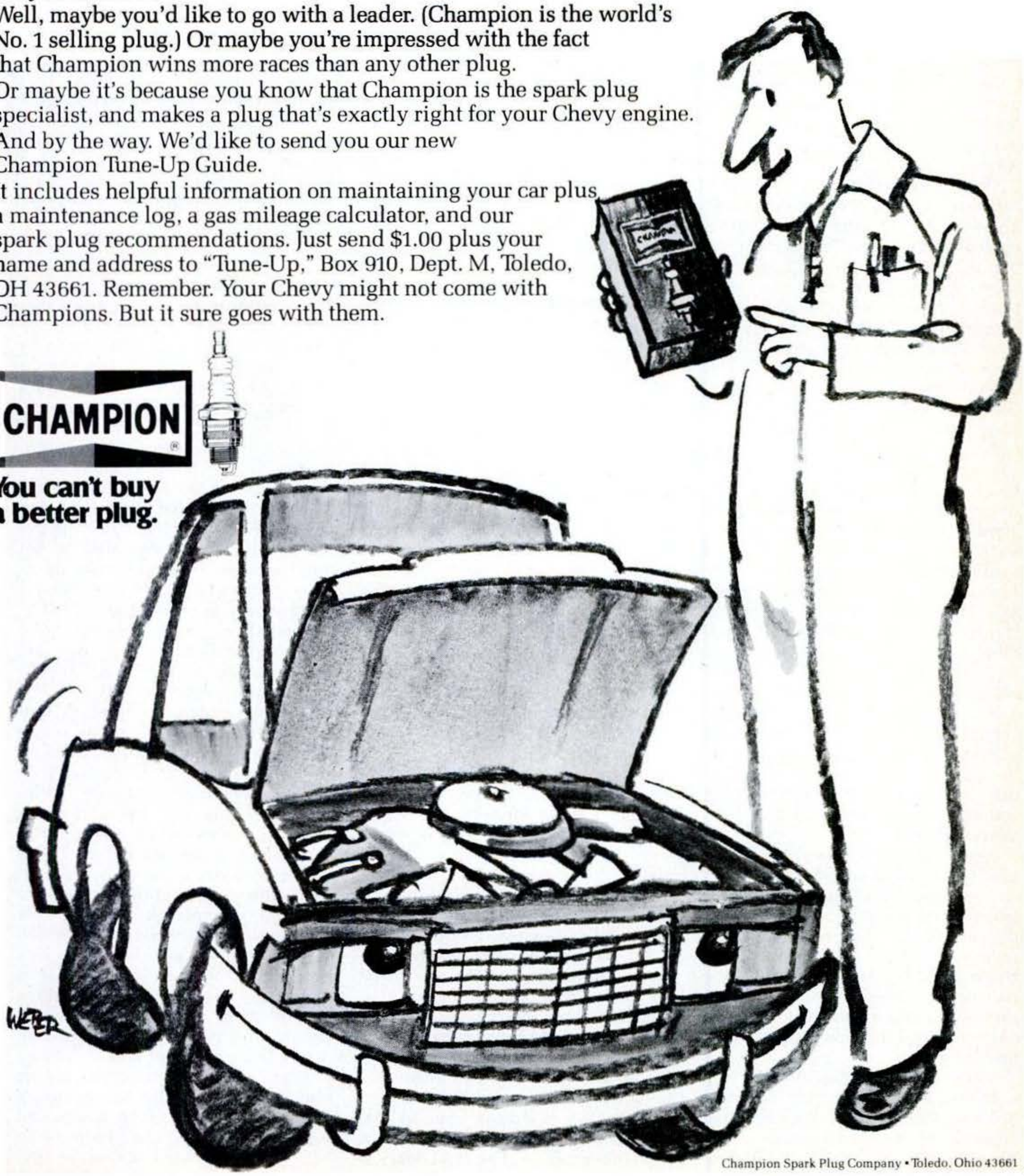

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arrangement of cells whose membranes are groups of disordered atoms, an arrangement that managed to encode information efficiently. That view led him to study the way in which another kind of apparently disordered substance, amorphous materials, could encode information. That led Ovshinsky and his wife, Iris, to found Energy Conversion Devices to pursue his dream.

Chalcogenide-glass paradox

In the past few years, the theory of amorphous semiconductors has made enormous strides, thanks in part to the work of Anderson and Mott.

Both were trying to explain a paradox about the chalcogenide glasses. All of the atoms in a chalcogenide glass appear to be bonded the way the textbook says they should. For example, selenium, one of the chalcogens, is supposed to form two bonds per atom. The book says that if selenium bonds imperfectly, you should be able to detect the unbonded electrons by detecting their spins.

No one could detect unpaired electron spin in the material. On the face of it, the lack of spin meant that all the atoms were bonded perfectly and that no defects were present. That would mean that a chalcogenide glass was equivalent to pure crystal, all of whose atoms are also bonded perfectly. Therefore, adding a small amount of dopant to a chalcogenide glass should change its electrical conductivity.

But doping did not affect the conductivity of chalcogenide glasses. Something was sopping up the dopant electrons and holes; the material had defects that couldn't be explained in any conventional way.

Anderson took the first step toward an explanation by making an analogy. It is known that electrons form pairs in superconducting materials. Anderson said the same thing must be happening in chalcogenide glasses and that the pairing of electrons was what sopped up dopant material. But he couldn't explain how the pairing might happen.

Mott went one step further: He said that electron pairing occurred because there might be imperfect bonding in the chalcogenide glass. There would have to be "dangling bonds"—free electrons—to do the pairing with the added electrons, Mott said. But he didn't explain where those free electrons came from.

The explanation came from Marc Kastner and David Adler of MIT and Helmut Fritzsche of the University of Chicago, who say that they got the clue from Ovshinsky. There are free electrons, the theory goes, because every selenium atom doesn't form two bonds. Most do form two bonds, but some form one bond and some form three. The average is two bonds per atom, but there still are plenty of dangling bonds to sop up added electrons.

Adler and Fritzsche credit Ovshinsky not only for having the first intuitive understanding of the principles of amorphous semiconductors but also for developing the technique for making usable materials. To start with, Ovshinsky said that large amounts of material would have to be added—instead of a few parts per thousand, more than a part per hundred. The tiny amounts added to crystalline semiconductors are called dopants; Ovshinsky calls the materials that are added in great quantity to amorphous semiconductors "modifiers."

> "Some of the world's leading physicists believe passionately in his work; others talk about him in sentences that prominently feature the word 'but'"

The old method was to add modifiers to the molten glass, which was then allowed to cool slowly. The approach developed by Ovshinsky is to sputter or evaporate the modifier onto a cold surface of amorphous material. Apparently, the slow cooling allowed the modifying atoms to become fully bonded, which eliminated the needed free electrons or holes. Sputtering them on keeps the atoms from bonding fully.

ECD has not marketed threshold switches for business reasons, Ovshinsky says. Instead, it has been concentrating on films made of amorphous materials, the kind of film that Dave Strand showed me. In the film materials, there is a two-step process. The first step is threshold switching. In the second step, the material changes its molecular structure, which means that its opacity changes. This sort of change is useful because it permits flexibility. In ordinary film, one exposure permanently changes the entire area of the film. In ECD's amorphous film, any part that hasn't been exposed can be changed later. You have a film that you can add images to over a long period of time.

Or you can have a different (but related) amorphous material that demonstrates "memory switching": It will change in conductivity rather than opacity when it receives an electronic pulse. That kind of material can be used for a new type of computer memory.

Alterable computer memory

The computer memory is a cross between the permanent memory that contains the basic operating instructions for a computer, and the temporary, erasable memory that contains instructions for a given job. Using ECD's memory material, the basic core memory can be changed at will, and it will remain in the new state indefinitely, to be changed again when the operator desires. This means that the basic characteristics of a computer can be changed simply and cheaply in a way that is not now possible. The alterable memory is being marketed by Burroughs Corp. under agreement with ECD.

Several different devices evolving from ECD technology now are on the market or close to it. The 3M Co. has an agreement with ECD to sell a new microfilm system that ECD produces. With today's systems, once you put a document on film, the record can't be changed. At ECD, I watched engineer Peter Klose not only add new entries to a microfilm sheet but also write comments on an old entry. I also saw a demonstration of a machine that allows microfilm entries to be made simply by typing the information into a computer, which turns the data into electrical impulses that develop the film. That machine might someday allow businessmen to put their day's results directly on microfilm by phone from a distant city.

Then there's the lithographic film, for which ECD has licensing agreements with Fuji in Japan and Agfa in Germany. The film is made

[Continued on page 188]

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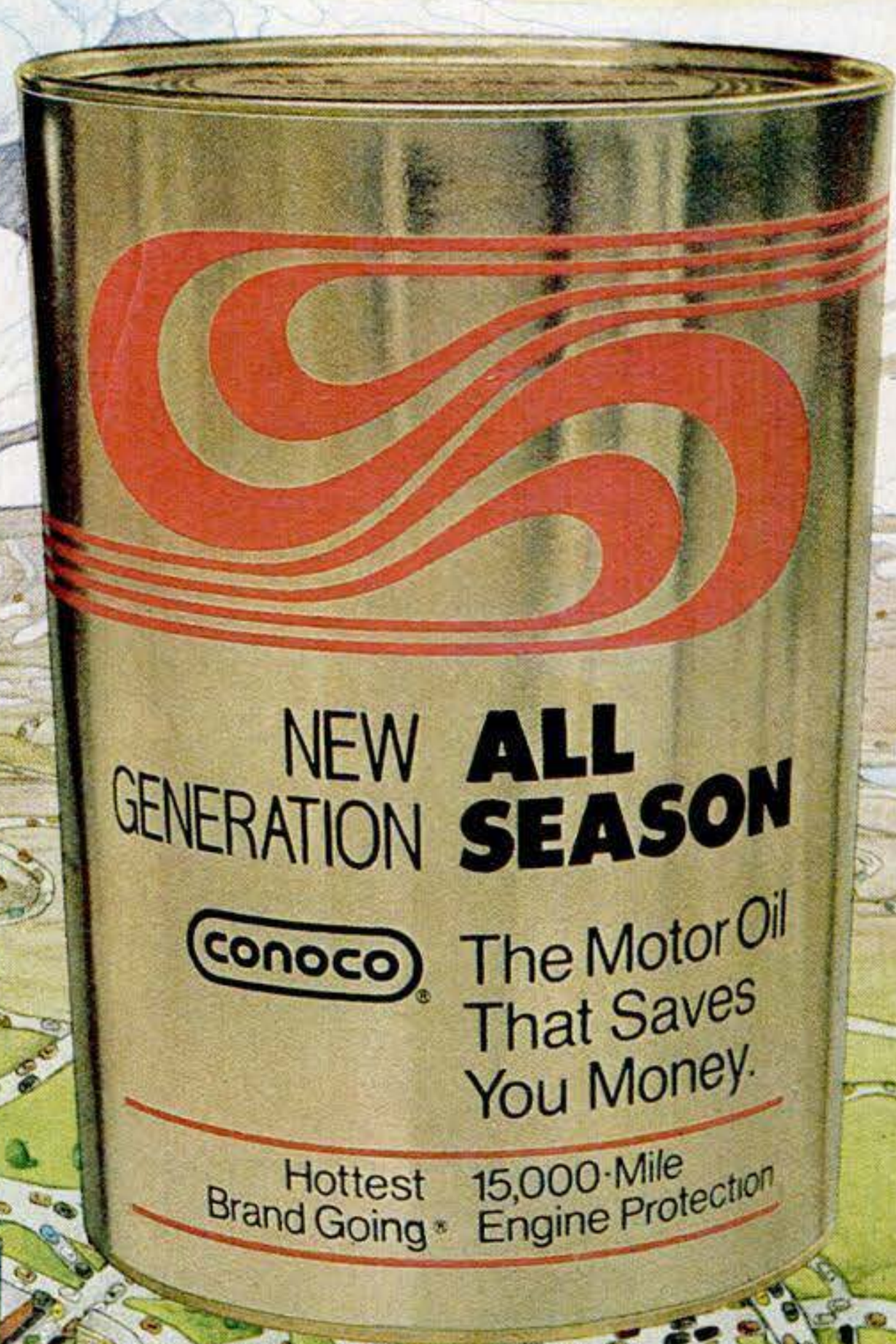

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Best buy in low-cost stereo receivers

You'll find excellent quality in receivers for under $300

By LEN FELDMAN

In my lab, I test and evaluate many hi-fi components—everything from super-powered basic amplifiers to inexpensive "compacts." My conclusion: If you're planning to buy a stereo component system on a limited budget, your best buy is an all-in-one receiver carrying a suggested retail price of $300 or less (which you can usually get for a lot less than that—just by shopping around).

For that price, you can get a perfectly acceptable power rating, good tuner specifications, and plenty of features. But, in general, each model has slight trade-offs in its design. And those trade-offs could be important to you, depending on how the unit will be used and the speaker system it will be driving. Those considerations should be kept foremost in your mind when you shop.

Features and trade-offs

Generally, I found that receivers priced near the $300 mark that offered less than 35 watts per channel usually substituted some feature or other as a trade-off. For example, the Sansui G-3000, with a suggested price of $280, delivers only 26 watts per channel of audio power. But it has a microphone input and a separate level control that enable you to mix your voice with other program sources. The Scott R-327, at around $260, delivers only 25 watts per channel, but it incorporates a Dolby de-emphasis switch. That means that you need only connect a Dolby adapter to one of the two tape-monitoring circuits to enjoy any Dolby FM broadcasts in your area (see box, p. 193). The broadcasting is correctly decoded without modifying your tuner section for the correct high-frequency roll-off needed for Dolby broadcasts. And the addition of such a decoder will not preclude connecting a tape deck to the system since the Scott R-327 is equipped with two tape-monitor circuits.

Many audiophiles have told me that one of the more important features they look for in a receiver is the presence of at least two tape-monitor circuits. This permits you to hook up two tape decks and to "dub" recordings from one to the other. Normally, this feature is found in higher-priced receivers, but three in our low-priced group had it: the Pioneer SX-650, Scott R-327, and Technics SA-5270.

The Sherwood S-7210A also has two tape-deck connection circuits, and either connected deck can be "monitored" as recordings are made (providing the deck has separate record and playback heads). This unit, however, does not have an additional tape-to-tape dubbing switch, so, when you copy from one deck to another, you'll have to patch up cables externally rather than just throwing a front panel switch.

If you simply plan to install a single tape deck (either cassette or open reel), you'll find that all of the remaining receivers have at least one tape-out/tape-in or tape monitoring circuit for that purpose.

Understanding power specs

For most of us, these low (considering the 200-watt brutes avail-

Continued

PHOTOS BY BOB BRODY

Author Len Feldman is a prominent writer and consultant for the hi-fi industry as well as technical director of the Institute of High Fidelity. All tests on the receivers, such as this Advent, were performed in his lab.

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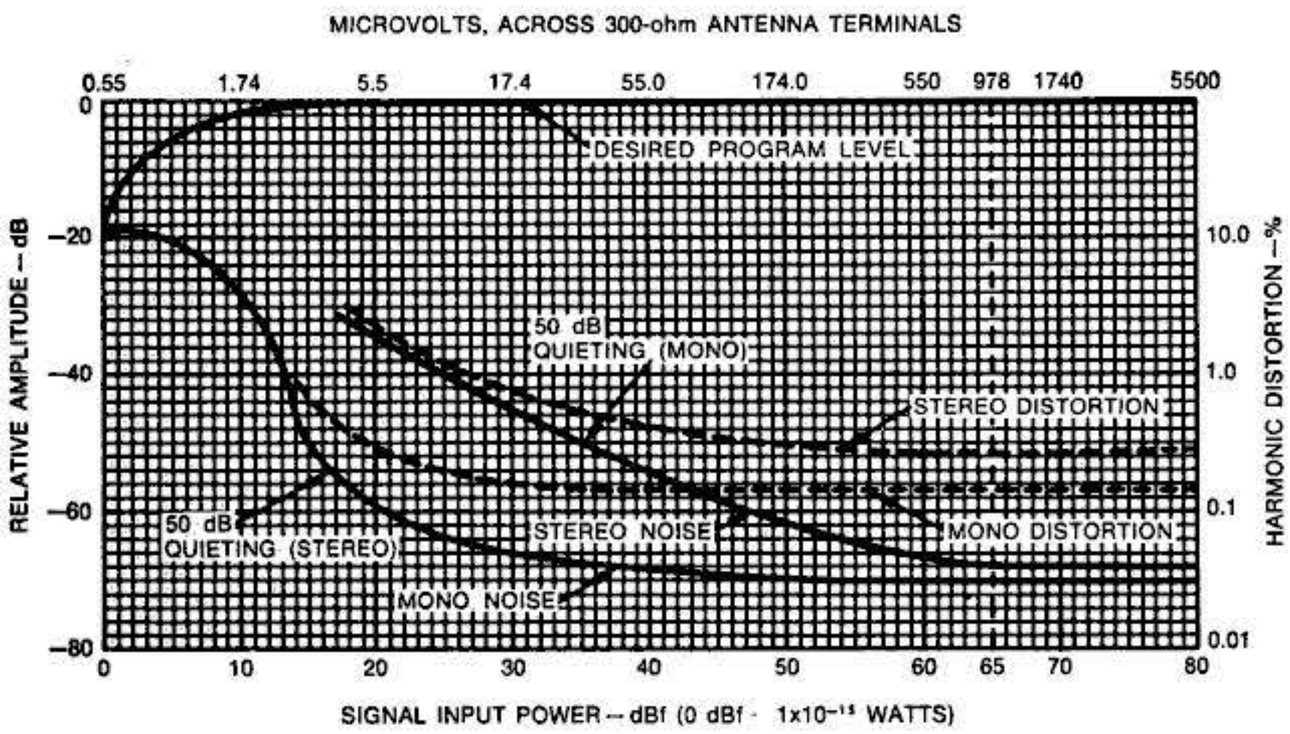
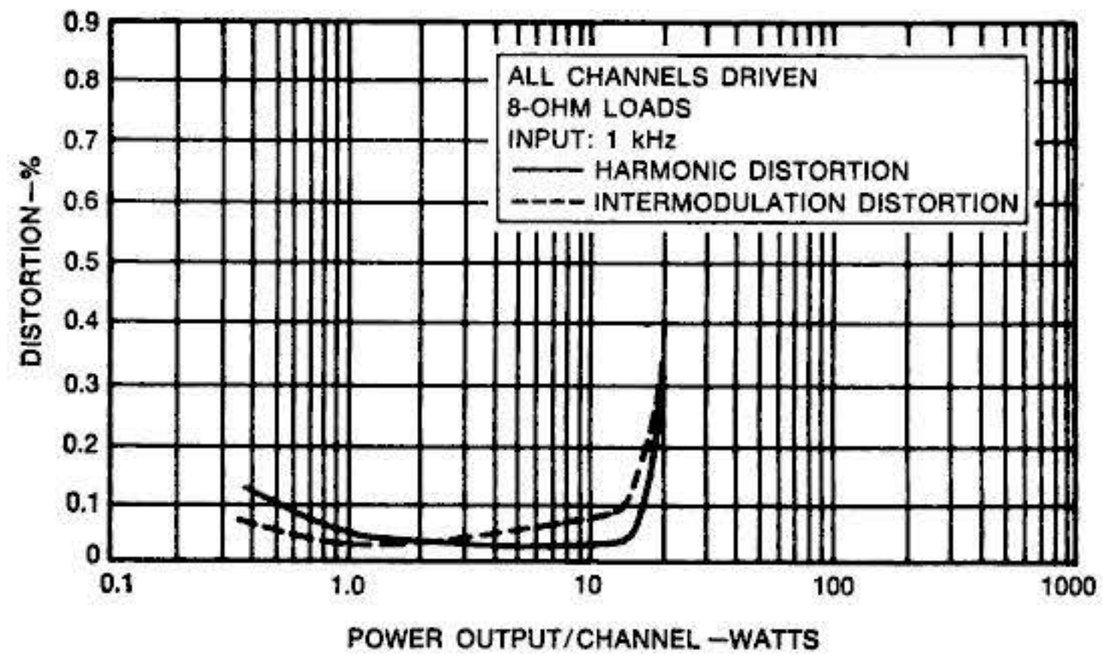
[Continued]



As FM signal strength increases, background noise and distortion decrease rapidly to the ultimate or lowest value. When noise is 50 dB lower than the signal, the receiver is capable of delivering good sound. More signal strength is required to reach this point in stereo than in mono.



Distortion ratings for stereo receivers, as quoted in specification sheets, usually tell what the expected harmonic or intermodulation distortion will be at or above rated output. At all lower power-output levels, distortion is much lower and, for all practical purposes, inaudible.

able) power ratings are more than enough. Today's more efficient speaker systems require far less power input for a given amount of sound output than the diminutive, "sealed enclosure" designs that were popular a decade ago. Some of today's high-efficiency speaker systems can deliver as much sound when powered by 15 watts or so as do the older, lower-efficiency speaker systems when fed with five or 10 times that power level!

The first four columns in our table spell out the continuous power capability of the 14 receivers I checked and give several other facts relating to power output. Power bandwidth is defined as the frequency extremes over which the amplifier section of the receiver will deliver its full rated power. All but two manufacturers rated their power output at such a level that full power is obtainable from 20 Hz to 20 kHz—the nominal spectrum of human hearing. If a manufacturer

Continued

SUMMARY OF PERFORMANCE SPECIFICATIONS OF 15 RECEIVERS IN THE UNDER-$300 PRICE RANGE

Manufacturer and model no.	Power/channel at 8 ohms (watts)	Power bandwidth (Hz to kHz)	Rated harmonic distortion (%)	Rated intermodulation distortion (%)	Phono input sensitivity (mV)	Phono overload (mV)	Phono S/N (noise) re:10mV (dB)	Number of tape circuits	Tape dubbing?	Special features	FM usable sensitivity (μV)	Mono 50-dB quieting sens. (μV)	Stereo 50-dB quieting (μV)	Mono FM signal-to-noise (dB)	Stereo FM S/N (dB)	Total harmonic distortion @ 1 kHz, FM (%), mono	THD @ 1 kHz, stereo FM (%)	Selectivity (dB)	Approx. price ($)
Advent 300	15	20-20	0.15	0.15	2.0	100	80	1	No	Center-tune lights	n.a.	3.5	35	n.a.	n.a.	0.15	0.2	70	270
Fisher RS-1035	35	20-20	0.2	0.2	2.0	70	70	1	No		1.9	2.8	38	70	66	n.a.	n.a.	68	300
JVC JR-S200-II	35	20-20	0.5	0.5	2.5	170	87	1	No	Power Meters	n.a.	3.5	40	78	65	0.2	0.4	60	300
Kenwood KR-2600	15	10-45	0.8	0.8	2.5	140	70	1	No		2.5	4.5	50	70	64	0.3	0.5	50	200
Marantz 2216B	16	20-20	0.15	0.15	2.5	100	74	1	No		n.a.	3.2	40	75	65	0.2	0.4	70	280
Pioneer SX-650	35	20-20	0.3	n.a.	2.5	200	82	2	Yes	Tone defeat	1.9	3.1	44	70	65	0.15	0.3	60	300
Realistic (Radio Shack) STA-85	35	20-20	0.3	n.a.	2.5	120	n.a.	1	No	4-Channel simulate	2.0	2.0	25	70	n.a.	0.1	0.3	50	300
Rotel RX-503	35	20-20	0.17	0.1	2.5	120	n.a.	1	No		1.9	4.0	50	70	65	0.1	0.3	70	300
Sansui G-3000	26	20-20	0.15	0.15	2.5	200	75	1	No	Microphone mixing	1.95	4.9	48	70	67	0.18	0.25	n.a.	280
Scott R-327	25	20-20	0.3	0.3	2.5	100	n.a.	2	Yes	Dolby de-emphasis	2.2	3.5	40	68	65	0.3	0.5	52	260
Sherwood S-7210A	30	20-20	0.5	0.5	2.0	110	n.a.	2	No	Synthesize 4-channel	1.9	2.8	n.a.	70	n.a.	0.3	0.6	65	260
Sony STR-2800SD	20	20-20	0.5	0.5	2.5	100	80	1	No		2.0	4.0	45	70	68	0.2	0.4	50	210
Superscope R-1270	35	40-20	1.0	n.a.	3.0	n.a.	n.a.	1	No	4-Channel simulate	n.a.	n.a.	n.a.	65	n.a.	n.a.	n.a.	40	300
Technics (Panasonic) SA-5270	35	20-20	0.3	0.3	2.5	130	90	2	Yes		1.9	2.7	39.7	75	70	0.15	0.3	70	280

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For outstanding engineering achievement in television, General Electric has won an Emmy.

The National Academy of Television Arts and Sciences has honored General Electric for 'The First Application of the Vertical Interval Reference (VIR) Signal System to Television Receivers.'

The VIR signal was designed by a TV industry committee to correct distortions in the TV color signal as it passed from network sources, through communications systems, to homes. The development of VIR was a big step in color broadcasting.

The next challenge was to design a TV set that could use it. General Electric developed the VIR Broadcast Controlled Color System. And won an Emmy for being the first to use VIR in TV sets.

GE VIR color sets have computer-like circuitry which uses the broadcaster's VIR signal to automatically adjust color and tint, sixty times a second, on many programs.

You owe it to yourself to see GE VIR color TV in action before you buy a new set. See a demonstration today.

Cabinet: Walnut finish on high impact plastic.

THIS IS GE PERFORMANCE TELEVISION

GENERAL ELECTRIC

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wanted to rate the product at slightly higher power, he could probably accomplish that advertising ploy by accompanying the higher power figure with a more restricted power bandwidth specification. For example, had Marantz wanted to quote a 20-watt-per-channel power rating (instead of the more honest 16-watts-per-channel it chose to use), it might have had to restrict the published power band to from 40 Hz to 15 kHz. I have found that almost without exception the receivers in this group can deliver substantially more power at mid-frequencies than they can at the frequency extremes of 20 Hz and 20 kHz, where low-distortion output is more difficult to achieve.

But note that the Superscope R-1270, though rated at 35 watts per channel, has a somewhat restricted power band extending only from 40 Hz to 20 kHz. In other words, at the low frequency extreme of 20 Hz, this receiver cannot deliver its rated 35 watts per channel of power output.

How important is this consideration to you? That all depends upon the response capability of your speaker systems. If your speakers roll off rapidly below 50 Hz anyway (as most low-to-medium-cost speakers do), the limited bandwidth may not be a significant factor. On the other hand, if you mate this receiver with superior speakers that do have essentially flat frequency response to below 40 Hz, don't expect to drive them at those lower frequencies with the full 35 watts per channel quoted for the Superscope unit at low distortion levels.

Speaking of rated distortion figures, I noted that manufacturers chose to list them from a low of 0.1 percent to a high of 1.0 percent. Here, too, a manufacturer can make certain trade-offs in rating the power output of a receiver or amplifier. For the Model 300 receiver, if Advent had been willing to quote a rated harmonic distortion of 0.5 percent instead of 0.15 percent as it did, the rated power output might have ended up at a higher number (that is, 16 or 17 watts per channel, instead of the quoted 15).

I found that the distortion ratings of the receivers had little or no relationship to the way the receivers sounded when delivering less than their full rated output. The graph of distortion versus power output illustrates why this is true. At all power levels below rated output, both harmonic distortion and intermodulation distortion are far below their rated values and are all but inaudible under musical listening conditions. In fact, every one of the receivers evaluated actually delivered somewhat more power output (for rated distortion) than their published specifications indicate.

> "If you're planning to buy stereo components on a limited budget, your best buy is an all-in-one receiver"

This power reserve or safety factor is built-in insurance against possible accusations of exaggerated advertising claims that might be made by the Federal Trade Commission. (In 1974, the FTC promulgated a rule telling audio amplifier and receiver manufacturers exactly how they must specify audio power-output ratings so that one product's power capability can be compared meaningfully with another's.)

FM performance

Chances are that next to records, FM stations will supply most of your listening music. Although most receiver manufacturers stress the "usable sensitivity" figure of their tuner sections as if this were the most important FM performance specification of all, there are other specs that are far more important. In terms of weak-signal reception, the newer 50-dB quieting-sensitivity specification (for both mono and stereo operation) tells us a great deal about how much signal strength must reach the antenna terminals of the receiver for us to enjoy a program with signal-to-noise ratios of 50 dB (the agreed-upon minimum for high-fidelity listening). As you can see in the listings, it takes a good deal more signal strength to reduce background noise by 50 dB (compared to desired program level) for a stereo signal than it does for a mono transmission. This is an inherent characteristic of the stereo broadcasting system used in the U.S. Of course, a good outdoor antenna will bring in more signal and result in greater background-noise suppression for all of the receivers I checked. Based upon published specifications, the Radio Shack (Realistic) receiver would seem to reach acceptable background-noise levels with a bit less incoming signal strength than the others (both in mono and stereo). Under actual listening tests, however, the Fisher RS-1035, Marantz 2216B, Sherwood S-7210A, and Technics SA-5270 delivered as low a background noise level for relatively weak incoming signals. Given a strong signal, the JVC JR-S200-II boasts the best ultimate quieting figure (78 dB) in mono, while the Technics SA-5270 claims a 70-dB ultimate quieting figure in stereo. The Sony STR-2800SD and the Sansui G-3000 are not significantly far behind with readings of 68 dB and 67 dB respectively. Under actual listening conditions, background-noise level (un-

Continued

dBf takes over from microvolts

Traditionally, manufacturers of FM tuners and receivers have quoted the various signal-sensitivity ratings of their products in terms of microvolts (millionths of a volt) of signal reaching the antenna terminals. Unfortunately, this method can raise some ambiguities, since it's really the power of an incoming signal and not the voltage that counts. A given number of microvolts applied to a 75-ohm antenna terminal corresponds to twice as much power as that same number of microvolts if applied to a 300-ohm pair of antenna terminals (power equals the square of the applied voltage, divided by the resistance of impedance: $P = V^2/Z$).

To eliminate that ambiguity, recently approved tuner and receiver measurement standards have adopted a power notation for signal strength rather than voltage. But, since we are dealing with very minute wattages, it is convenient to establish a decibel reference against which other powers can be compared in dB. The reference for 0 dB chosen is one femtowatt, or 1×10^{15} watts. That reference is called 0 dBf (0 dB with respect to 1 femtowatt).

In reading the latest FM receiver sheets, you may find voltage notations, dBf notations, or both. It is relatively easy to convert from microvolts to dBf. The formula works out to be:
$dBf = \text{Log}_{10}\ \mu V/0.55$.

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1. Sweet '78 styling. A subtle and sleek new look that's clean and kinda elegant. **2.** Our full line ...travel trailers, motor homes, mini-motor homes, fold-down camping trailers, van campers, truck campers and fifth wheels.

3. Coachmen "Buck Stopper" customer service One-stop, trustworthy treatment at any Coachmen dealer nationwide and in Canada. **4.** The International Coachmen Caravan, your owners club. Each year, the Caravan holds an international rally and several Caravan trips to points of interest all over the continent.

Caravan has hundreds of local chapters and Caravan members get discounts on magazines, RV accessories and other nice things.

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83. The best brand name equipment – Magic Chef®, Dometic®, Goodyear®, to name just a few. We keep good company.

84. Coachmen is America's best-selling name in RVs. Among other things, that means high trade-in value. **85-555.** Last but first, our hundreds of happy-to-serve-you dealers throughout North America.

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Comparing signal-to-noise specifications

One of the more important specifications of any audio component is its signal-to-noise ratio. Many listeners find it hard to detect harmonic or even intermodulation distortion during musical listening until it reaches one percent or even much more. But almost everyone is bothered by background noise, whether it be a random hiss or steady hum. As the term signal-to-noise implies, the decibel values given for this specification must always be referenced to some signal level.

Unfortunately, not all manufacturers use the same signal reference. Some may quote phono S/N with respect to the actual phono input sensitivity of their phono preamp sections. Suppose, for example, that 2.5 millivolts at the phono input will produce full output from a 50-watt-per-channnel receiver with an S/N figure of −65 dB in reference to that input. Then, with the volume control turned up fully, there will be 15.8 microwatts of noise. But, if the manufacturer had measured the S/N ratio with respect to a greater, 10-millivolt input signal, he would have had to *turn down* the volume control by some 12 dB in order not to overdrive the receiver. The measured hum-and-noise would then also go down by the same amount to a new figure of −77 dB. An unsuspecting shopper who didn't know the signal reference level might presume that this was a much better figure than the −65 dB quoted with reference to actual input sensitivity.

In our comparison table, we have referred all signal-to-hum-and-noise measurements to a standard value of 10 millivolts. In addition, we have used S/N readings that have been weighted in accordance with a so-called "A" weighting curve, which puts less emphasis on less-audible ultra-low and ultra-high frequencies than it does on the more annoying midrange and medium-treble noise components. Thus, our comparative S/N figures in Table I may be compared on an equal basis. Should you run into S/N specs based on some reference level other than 10 millivolts, here's how to convert that figure to the same reference levels we used.

If S/N figure is based upon a phono input signal of:	Add the following number of dB to the quoted S/N ratio
2.0	14
2.5	12
3.0	10.5
5.0	6
7.5	2.5
10.0	0

der strong-signal conditions) was limited not so much by the quieting capabilities of the receivers as by the nature of the program sources being used at the broadcast stations. (Records and tapes constitute most of the music broadcast over FM, with very little live-performance material available.)

The graphs illustrate the way in which noise and distortion (in both mono and stereo listening modes) tend to decrease in any FM tuner circuit as signal strength increases. They also serve to emphasize the importance of connecting a good FM antenna to any receiver, regardless of its price or power category.

The FM distortion values quoted for mono and stereo reception *are* reached every time a station modulates its transmitter to maximum levels. The distortion values shown may be reached regardless of the volume-control setting on the receiver because the distortion is a function of the tuner section itself. (This differs from the way in which an amplifier's distortion increases to rated values only when full power output is delivered by the amplifier.) Lowest FM distortion in mono is claimed by the Realistic STA-85 and the Rotel RX-503, with values of 0.1 percent. In the case of stereo listening, lowest distortion figures are claimed for the Advent 300 (0.2 percent) and the Sansui G-3000 (0.25 percent).

A specification that is more important to metropolitan city dwellers, such as myself, than to rural listeners, where there are fewer stations on the FM dial, is alternate-channel selectivity (often called, simply, selectivity). In areas such as mine, where there is practically no empty space on the FM dial, high selectivity figures mean that the receiver will be able to zero in on a desired signal without interference from another nearby signal. Of the sets evaluated, the Advent 300, Marantz 2216B, Rotel RX-503, and Technics SA-5270 performed best in this regard, with the Fisher RS-1035 and the Sherwood S-7210A following closely behind them. Of course, if signals are widely spaced on the dial in your listening area, high selectivity figures (measured in dB) are of considerably less importance. If you elect to purchase one of the receivers with poorer selectivity (the lowest in the group was the Superscope R-1270), you can still overcome alternate-channel interference to some degree by installing a highly directional outdoor FM antenna. These can be pointed in the direction of the desired signal and be less sensitive to signals coming in from other directions. If, as in my case, most of the transmitters in your area are located in one general area, this solution will not help, and you'd better look for one of the receivers that has a better alternate-channel-selectivity rating.

> "In fact, every one of the receivers delivered more power output (for rated distortion) than their specs indicate"

Phono considerations

All of the receivers listed will accept just about any magnetic phono cartridge at the phono input jacks. There were wide differences in noise and hum levels, with the Advent 300, JVC JR-S200-II, Pioneer SX-650, Technics SA-5270, and Sony STR-2800SD clearly ahead in this important performance specification. (See the box on this page for an explanation of the many nonstandard ways in which phono signal-to-noise is sometimes specified before trying to compare other receivers for phono hum-and-noise performance from printed brochures.) When it comes to hum and noise in phono reproduction, much depends upon how loudly you play your recordings. During very loud musical passages, residual hum and noise is pretty well masked by the music on all of the receivers listed. If your volume level is turned up high, though, and a soft passage of music comes along, you are more likely to hear background hum or noise when using the Fisher RS-1035, Kenwood KR-2600, or perhaps some of the models that provide no phono signal-to-noise specifications whatever.

The phono sections of any of the receivers that can handle a signal of at least 100 millivolts can be safely mated with even high-output phono cartridges without the danger of phono-input overload. This type

[*Continued on page 193*]

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Radial-Matic® rides so good it's almost against the law.

Radial-Matics will make whatever you put them on ride so smooth, you'll hardly know she's moving. In fact, it's the best-riding shock Monroe's ever built. Y'see, Radial-Matics combine—for the first time—five proven ride improvement features all in one shock.

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New Marlboro Lights 100's

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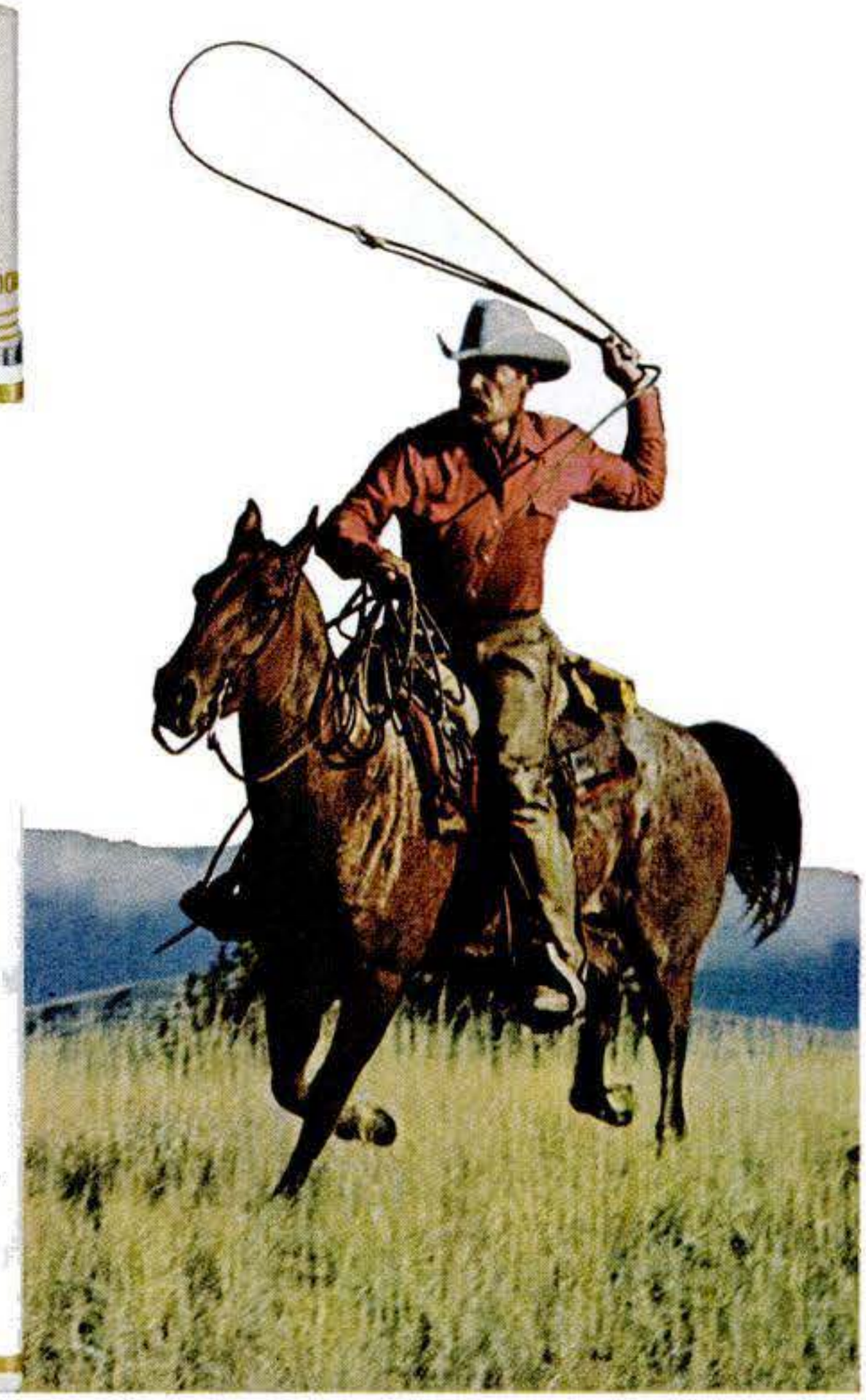

The spirit of Marlboro in a longer low tar cigarette.

Kings: 12 mg "tar," 0.7 mg nicotine av. per cigarette, FTC Report Aug.'77
100's: 12 mg "tar," 0.8 mg nicotine av. per cigarette by FTC Method.

Warning: The Surgeon General Has Determined That Cigarette Smoking Is Dangerous to Your Health.

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Popular Science

PS | What's News

Getting a good air-to-air photo is rarely as simple as just aiming a camera from a chase plane. When PS flying editor Ben Kocivar talked over plans for photographing this month's cover picture with Ralph Sawyer, pilot of the Skyjacker, Sawyer told Ben about another photo session in which he had been involved: An S-104 jet fighter plane snuggled a little too close to a B-70, got caught in the violent vortex turbulence from the big bomber's wing tip, and was whipped into a midair collision. With this ominous tale fresh in mind, they planned their shooting script —carefully. There would be two-way radio contact at all times and a definite flight plan. Skyjacker would fly predetermined steady headings. Ben and his pilot in the Cessna 172 would fly formation and maneuver for the best photo angles. The sky was overcast, but fast-moving clouds opened patches of sunlight here and there. Ben had four loaded Nikkormats with him so he wouldn't waste time reloading. On the radio he tried to talk Sawyer into beams of sunlight as they would pop through. It was frustrating. Just as he would get a picture framed in the viewfinder, desert air turbulence would bounce him or Skyjacker out of position. After dozens of near misses (photos, not airplanes), Ben captured the picture you see on the cover.

Nationwide Sun Day

Many of you are probably already involved with local groups in planning festivities for this nationwide celebration of solar energy. If not, it isn't too late to start. The celebration, Sun Day, designed to "lead the United States into the solar era," will take place on May 3. It is being organized by the same coalition of people and organizations that made Earth Day back in 1970 such a significant turning point in our attitude toward the environment. Among Sun Day events are teach-ins, demonstrations, and energy fairs. The day will begin with a sunrise celebration on Cadillac Mountain in Maine, where the sun first hits U.S. soil. Thousands of other events are planned across the country. Everyone interested can get into the act. If nothing is planned in your community, you can get it started. For more information call Richard Munson or Peter Harnik at 202-466-6880.

EPA studies mpg tests

If you have had reason to question the EPA's fuel-economy numbers, you are not alone. The people at EPA are having second thoughts about the way they get those figures. They recently put together a 26-page evaluation of the problem. Over the past four years, EPA has been comparing the fuel economy of the test vehicles that are supplied by manufacturers and from which the official EPA fuel-economy figures are obtained with that of a sampling of actual production cars. On average, in-use cars obtain about five percent lower city-driving and six percent lower highway-driving fuel economy. The biggest discrepancy is in the subcompact class. Yet to be explained is the observation that subcompacts with German-made engines showed the least difference while Japanese-made engines showed the most. The agency is working on methods to bring more reality to the numbers it publishes.

NMR whole-body imaging

Work on nuclear-magnetic-resonance techniques that can give detailed pictures of organ functions in sections through the human body [PS, Dec. '77] is spreading to commercial laboratories. Some observers are predicting that the technique could be in clinical operation within two years. The first research team to report results from whole-body scanning systems is led by Raymond Damadian, whose work we told you about last December. Now we hear that EMI, the giant electronics manufacturing company in the U.K., is working on equipment. Pfizer, a U.S. company, is sponsoring research at the University of California Medical School, and Philips of Holland is also developing equipment. Teams at the State University of New York at Stony Brook and at Nottingham University in England also have projects under way. Although it has been demonstrated that NMR radio signals can detect differences and changes in human tissue, the original hope that it could detect cancer in living human tissue has not yet been proven. Damadian is convinced that it can, but other researchers aren't sure.

Shiftless automatic

I get many queries from readers asking what has happened to new inventions or new technologies they've read about in past issues. Many people seem to assume when they don't see it on the market in a year or two that the new device was either "bought up by the big corporations to prevent competition" or that we misled them in our story. What they don't realize is the long and hazardous road a new invention must travel before it reaches mass production for the market.

I mention all of this by way of answering a reader about the variable kinetic drive described in our April 1973 issue. European Editor David Scott, who wrote that article, reports that Borg-Warner in Britain is working on the shiftless VKD automatic and is building a transmission designed for small front-drive cars with transverse engines. They are unwilling to talk about it now or give any further details, but Scott has picked up the rumor that it is for the 1979 Ford Fiesta.

Recycling crankcase oil

With more and more car owners changing their own oil, disposing of the used oil is becoming a dilemma. Many communities will not allow you to burn, dump, or bury what is drained from the engine. Since motor oil does not wear out—it only becomes contaminated and uses up the additives—the obvious solution is to clean it up, incorporate fresh additives, and use it again [PS, Aug. '76]. Now a non-profit program called SOAR (Save Oil America Recycles) has been started in California. It is co-sponsored by the California AAA and the California Service Station Association. Service stations displaying the SOAR decal will accept used crankcase oil and turn it in for recycling.

Hubert P. Luckett

Editor-in-Chief

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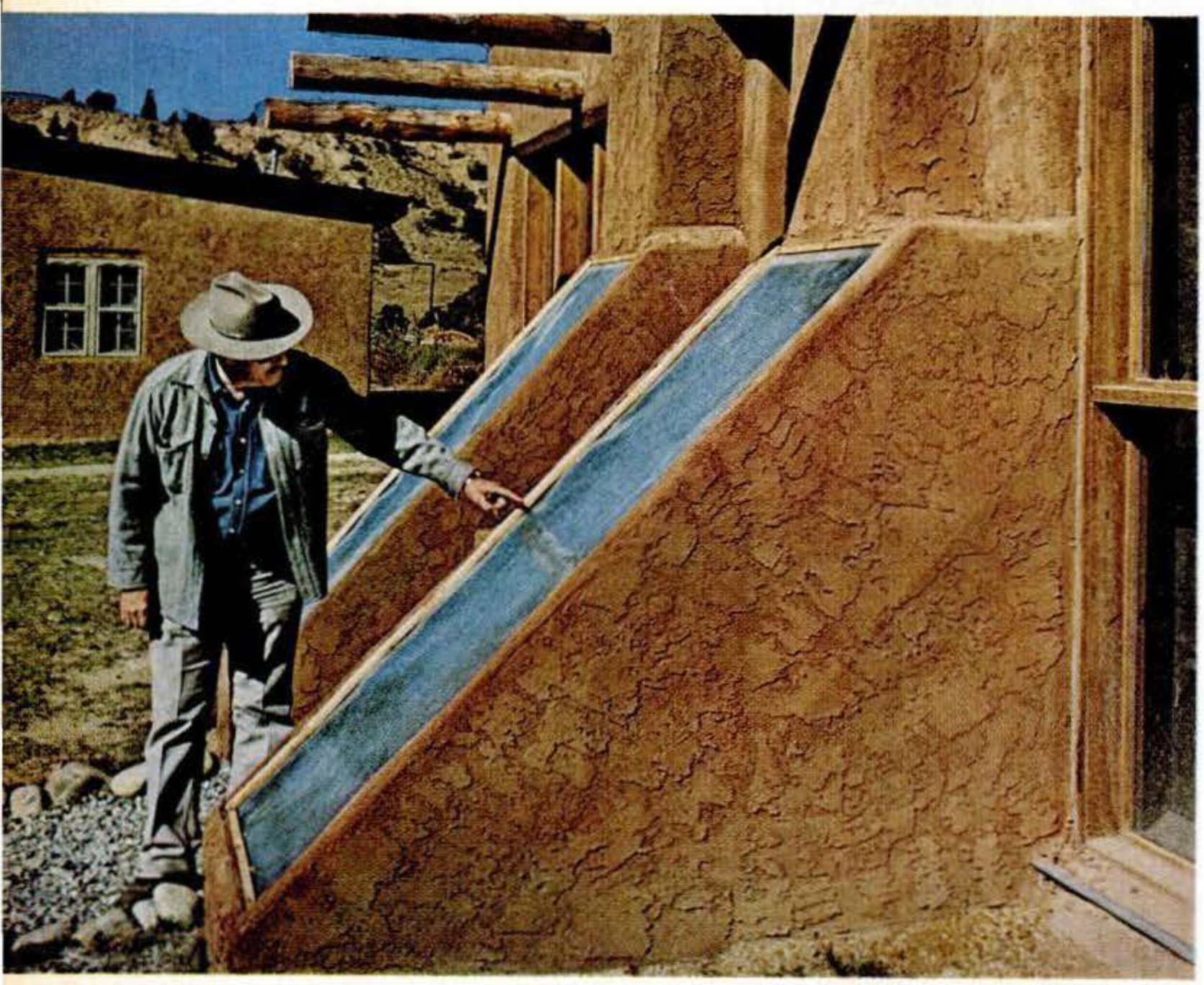
Passive solar
–a controlled experiment in home heating

Sundwellings at Ghost Ranch: Four adobe dormitories are identical in size, materials, and compass orientation, but differ



How can you keep solar heating simple? Scientists compare three different approaches in a unique test

By ARTHUR FISHER
PHOTOS BY THE AUTHOR

GHOST RANCH, NEW MEXICO

The sky was a piercing blue. The air, on a mid-October morning, was a brisk 50 degrees, but the sun burned with an intensity peculiar to the mountains. I was at Ghost Ranch Conference Center, a sprawling complex set in the wild and beautiful landscape of north-central New Mexico.

My guides were Aubrey Owen, community programs coordinator at Ghost Ranch, and Benjamin T.

Simple collectors for solar water heating are explained by engineering consultant "Buck" Rogers. The 40-gallon water tank is in a small attic where height is sufficient for thermosiphon circulation.

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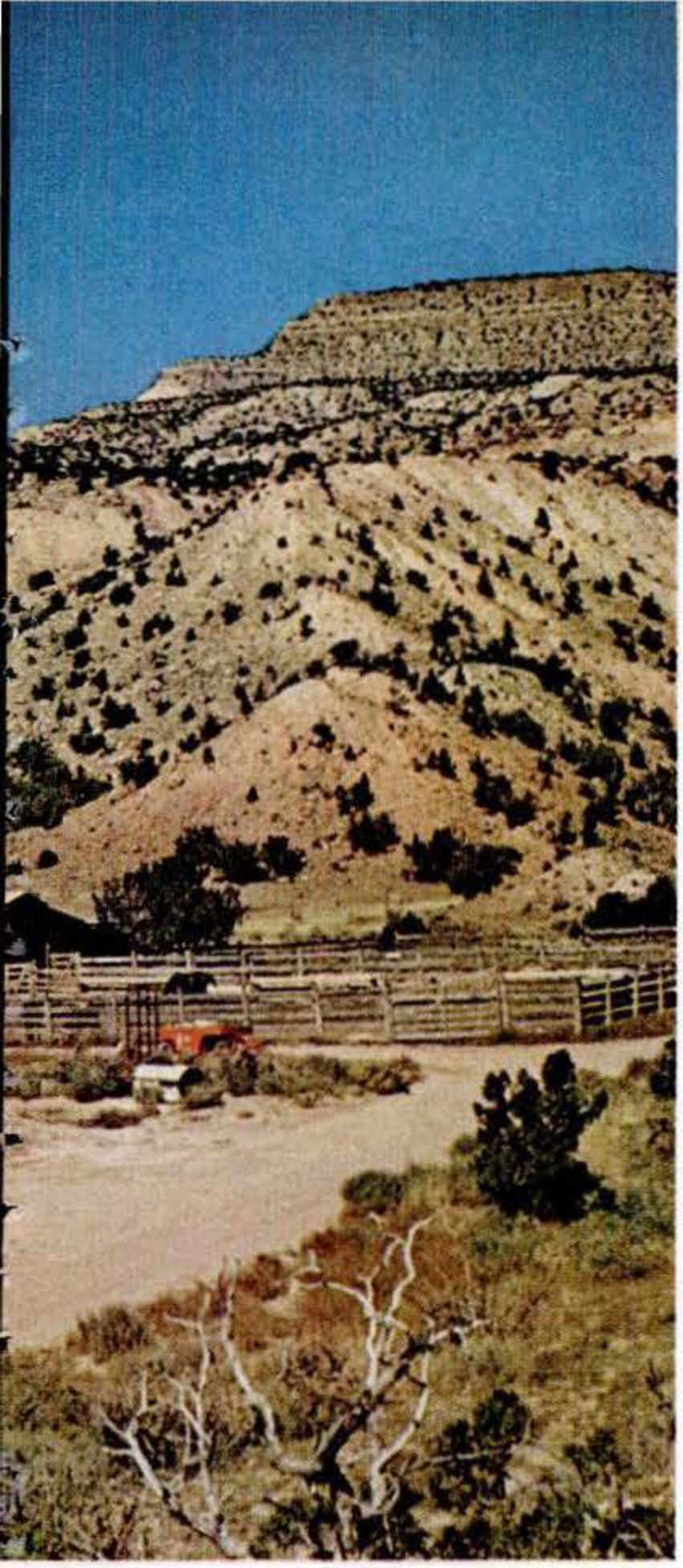
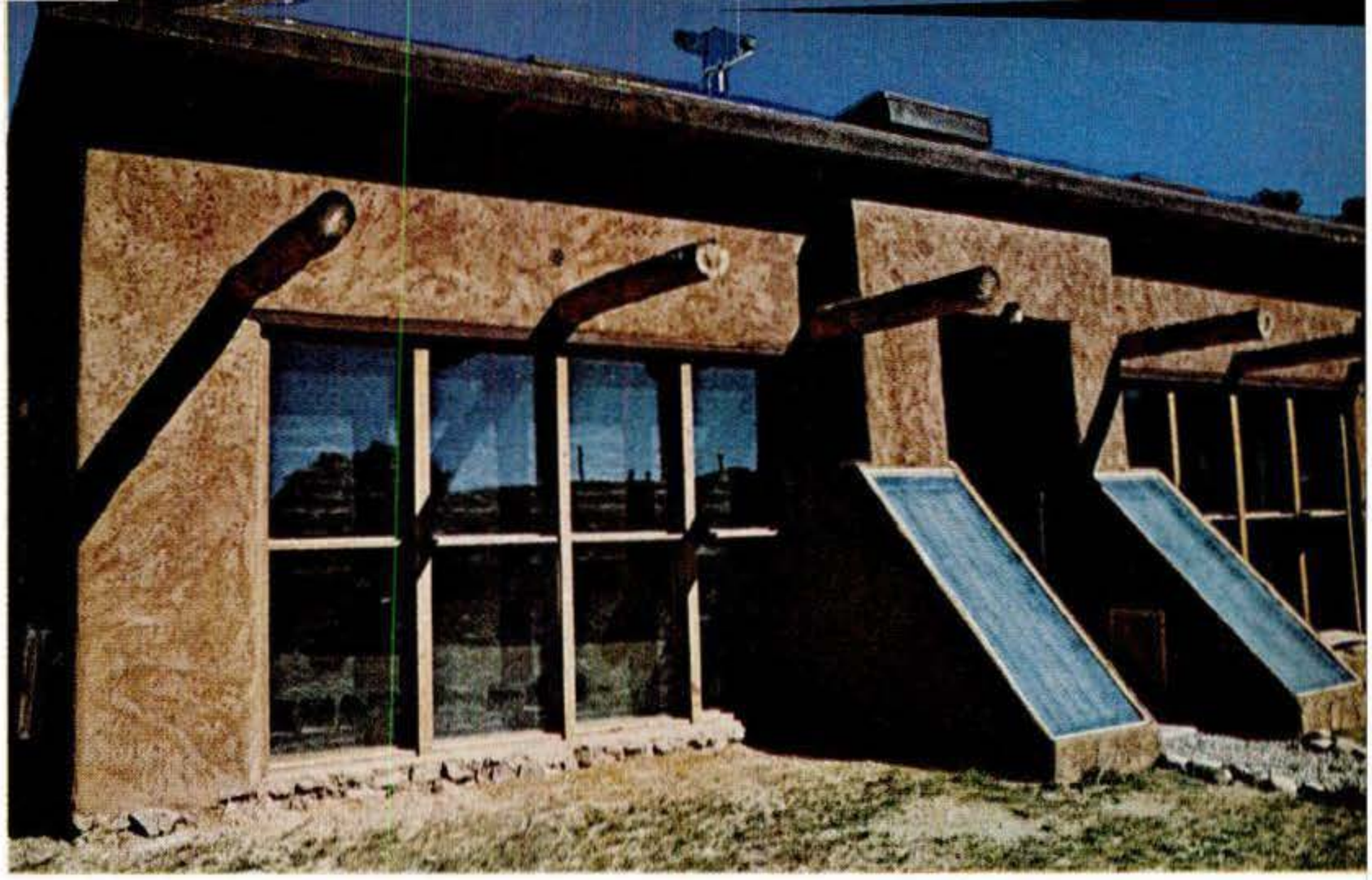


in their solar heating systems.



Two of the passive solar systems used in the Sundwellings appear above. Top photo shows unit with thermal storage, or Trombe wall. The Trombe wall can be seen behind double glazing; it is made of adobe painted black. Protruding round beams are *vigas*, peeled logs traditionally used to support roofs. Note weather monitoring instruments atop building. Bottom photo shows greenhouse unit, with plastic glazing for diffused light. Below, Aubrey Owen of Ghost Ranch demonstrates how simple cooling vent in ceiling is opened and closed.

(Buck) Rogers, engineering consultant to the Solar Energy Group at Los Alamos Scientific Laboratory (LASL) about 30 miles away. We had walked to the rim of a bowl where four small red buildings clustered.

"You're looking," Buck Rogers said, "at the only adobe buildings reinforced with thermocouple wire."

He was only half joking. The structures, called Sundwellings, exemplify the low-technology approach to solar heating: They use passive systems, energy conservation, and the humblest of local materials. Yet they are also part of a unique scientific experiment.

Each building is a 20-by-40-foot dormitory. They are identical in size, compass orientation, and con-

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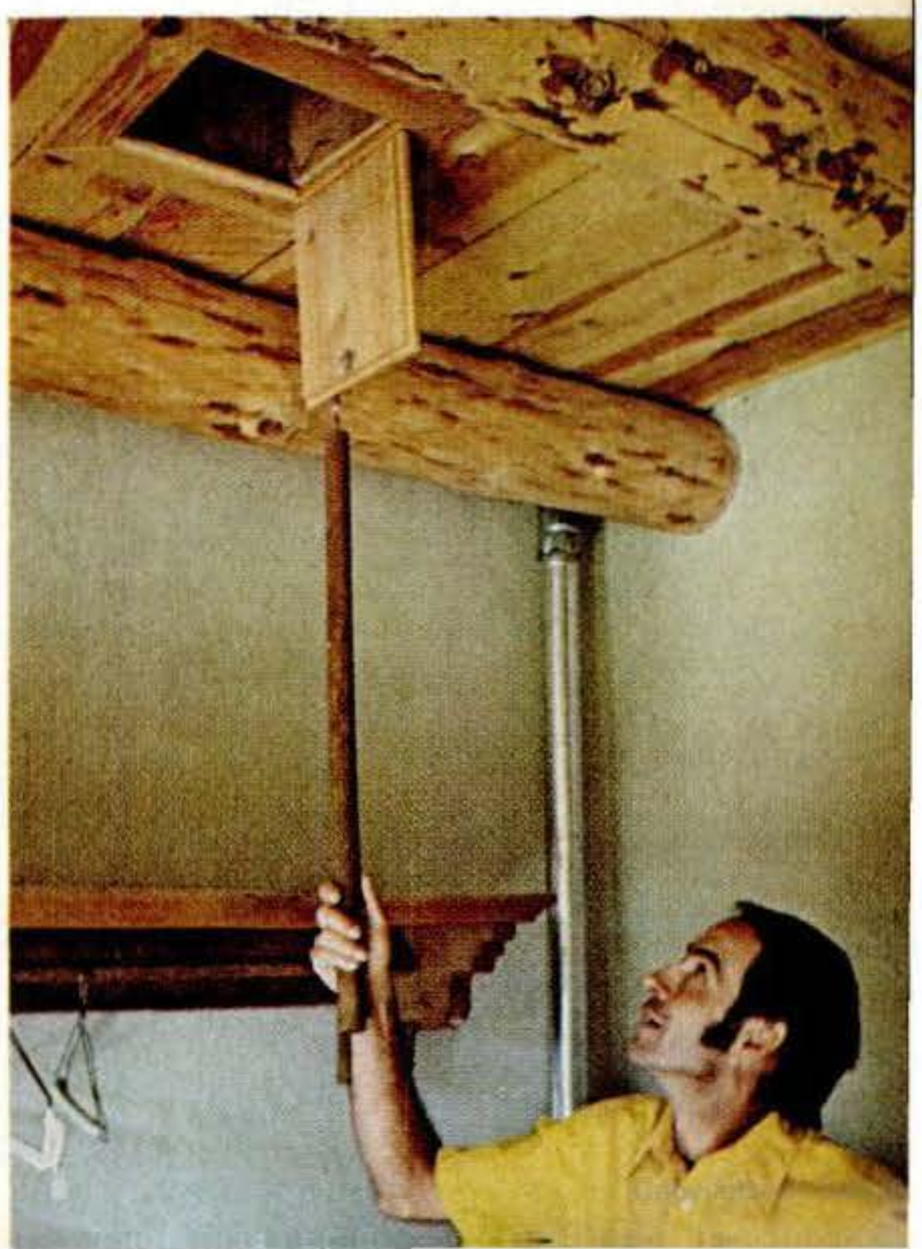
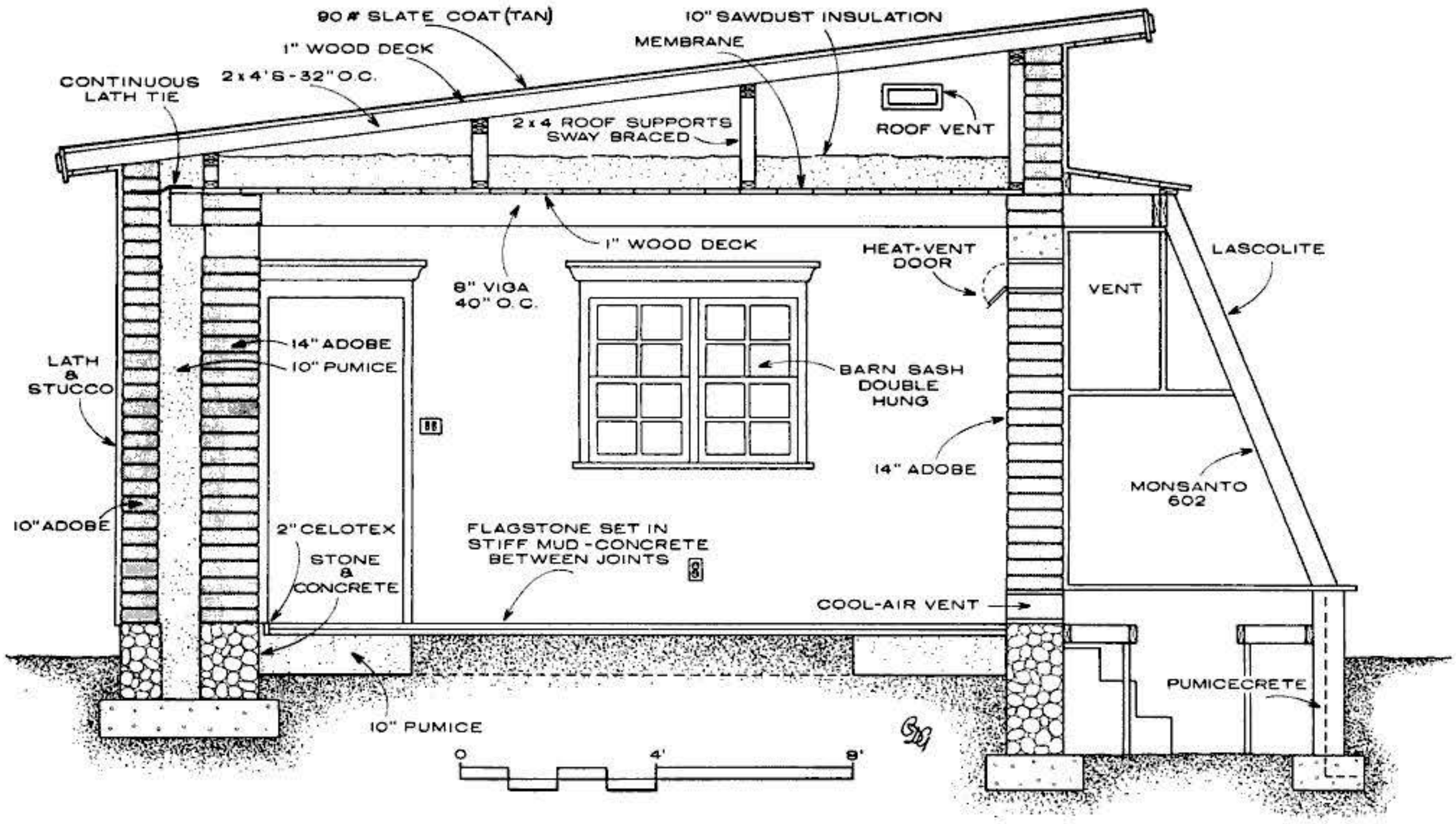


Hand-carved doors were fashioned by local craftsmen. Residents of northern New Mexico helped build Sundwellings as part of program to train local populace in solar construction techniques.



GREENHOUSE UNIT Drawing shows construction details common to all four Sundwelling units. Greenhouse is sunken 2½ feet into ground for frost protection, has double plastic glazing. Warm air from greenhouse rises into room through vent in wall; cool air sinks into greenhouse to be warmed. Adobe wall behind it warms room and greenhouse at night; heat is also stored in other walls and floor. Greenhouse can be closed off to prevent unwanted heat gain or loss.

struction materials. Three of the units employ solar systems—each a different variety of passive solar heating. The fourth, a control unit, has none. The thermocouples—about 50 embedded in each unit—together with a miniature weather station and recording equipment, will enable scientists at LASL to monitor the Sundwellings' performance. That's the first time we'll be able to compare different solar heating systems in a rigidly controlled way, and perhaps get some valid data on which works best—and why.

The Sundwellings project, Owen and Rogers told me, evolved when the Four Corners Regional Commission encouraged a group of solar experts to develop designs for houses that would meet the needs of poor farmers in New Mexico, Colorado, Arizona, and Utah. The group came to be known as the Sundwellings technical team, and was headed by solar pioneer Peter van Dresser. Eventually, the team decided to proceed with a combination demonstration and training program at Ghost Ranch, near Abiquiu, N.M. The funds came from the New Mexico Office of Manpower Administration, Four Corners Regional Commission, and Ghost Ranch Conference Center.

The aims of the project were dictated by a viewpoint as old as the culture that permeates this upland region, colonized by Spanish settlers as early as the seventeenth century.

The traditional Hispanic architecture is still ubiquitous. That building style uses materials that are cheap and locally available.

The Sundwellings team decided to use them too: adobe bricks that could be made at the site; the round ceiling beams called *vigas* that are simply logs felled in a nearby forest and then peeled; flagstone quarried locally; rough-hewn lumber; coarse sawdust for ceiling insulation; and pumice mined in the area for perimeter and wall insulation.

The actual construction of the units was carried out by Indian and Hispanic residents of the region as part of a training program.

Finally, the team chose three basic passive solar systems to demonstrate the feasibility of inexpensive, energy-conserving, ecologically sound architecture.

Under the direction of Dr. J. Douglas Balcomb, LASL is now monitoring a total of 11 different passive solar buildings across the country, including the four at Ghost Ranch, a program that reflects the Department of Energy's increasing interest in the technique. (We'll report on the results of this research in a future article.)

Just what is a passive solar system? The definition is somewhat slippery. Summarizing a meeting on the subject in New Mexico in 1976, Dr. Balcomb wrote that although some were in favor of dropping the term "passive" entirely, "I feel that we are stuck with the word and should probably make the best of it. I would define a passive solar heating and cooling system as one in which the thermal energy flows by natural means . . . convection or radiation."

The simplest type of passive solar architecture is the direct-gain approach, which uses a large area of south-facing glazing and a large amount of building mass to store the heat that enters through the window. The whole house acts, according to Dr. Balcomb, as "a sort of live-in solar collector."

A second passive approach is the thermal storage wall, or Trombe wall (named after the French solar physicist Felix Trombe). Here a massive wall, dark in color for maximum absorption, soaks up heat from sunlight pouring through the glazing. (The sunstruck surface of the Trombe wall at Ghost Ranch reaches 130° F.) The wall may consist of concrete or adobe or even water-filled drums.

The solar greenhouse is a passive system that combines the Trombe wall and direct-gain approaches.

Each of the solar Sundwellings units has a different one of these three generic types of passive solar space-heating systems. (The fourth control unit has no solar facade, just ordinary windows.)

Data-gathering from the Sundwellings is far from complete. "For one thing," Buck Rogers told me, "it takes some time for these buildings to come to equilibrium with the environment; there's a tremendous amount of water in new adobes, and they take a long time to dry out."

But on the basis of preliminary results, the dormitories are performing reasonably well. The night before my visit, the temperature outdoors bottomed at 26° F, but the interior of the greenhouse unit never went below 68° F. That was without turning on the butane backup heater that is provided in

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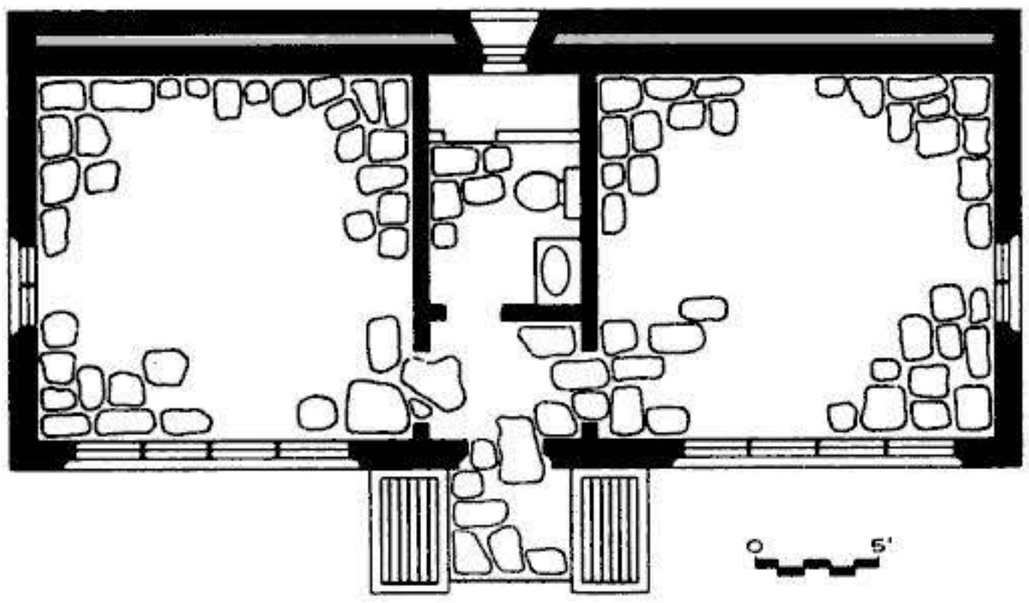
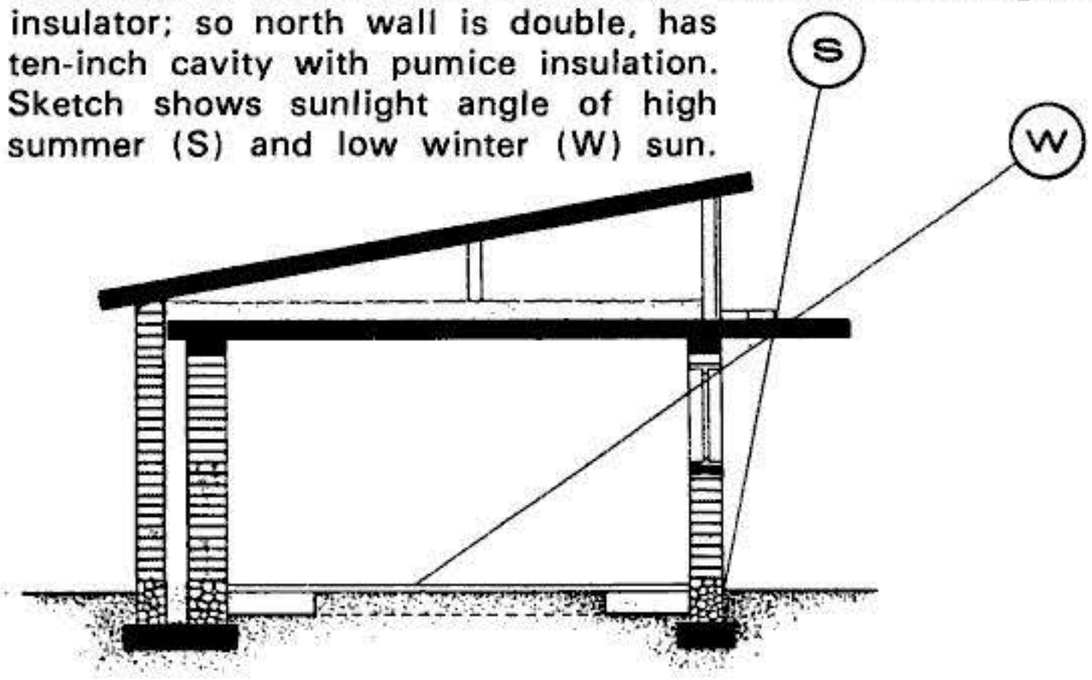
Sundwellings at Ghost Ranch: how the passive solar systems work

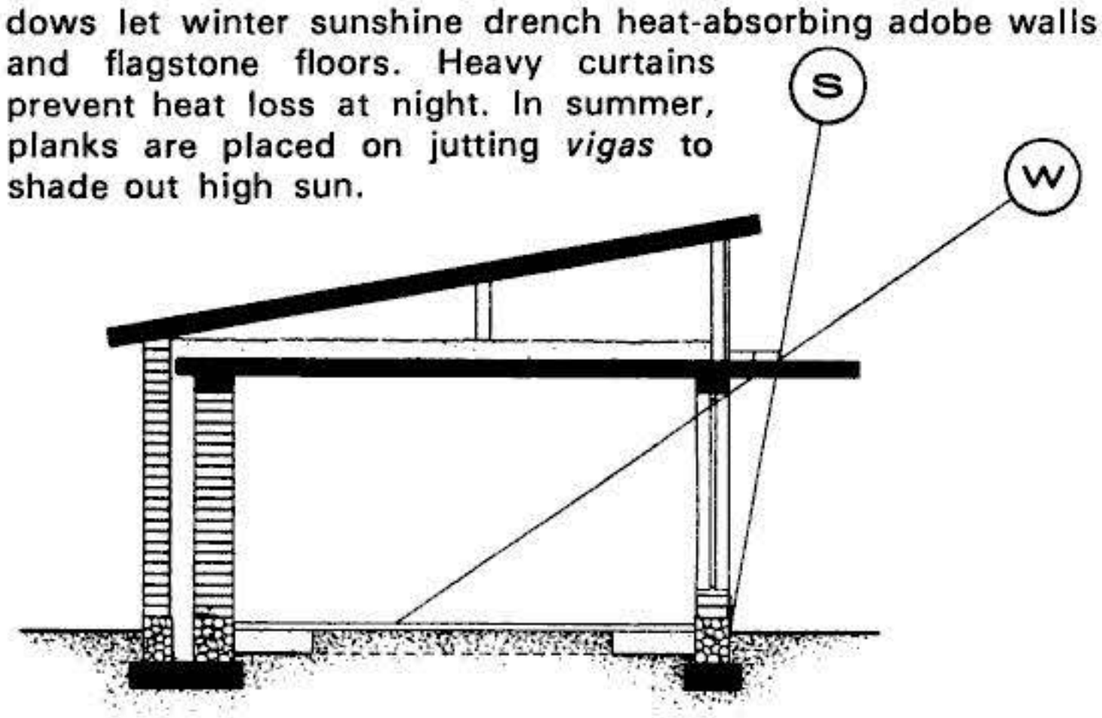


Basic floor plan of test units—two bedrooms plus bath

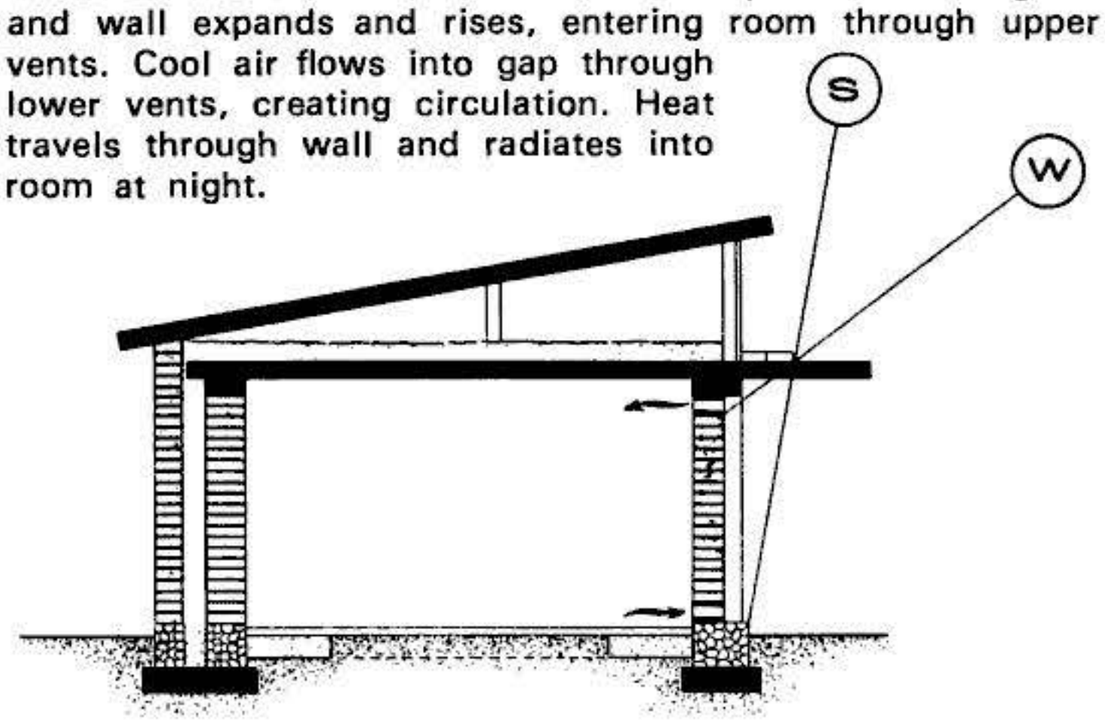
CONTROL UNIT Without special solar features, control unit is simplest of the Sundwellings (the most complex—the Greenhouse—appears on the facing page). Like all the units, it is made of adobe, which stores heat well but is not a good insulator; so north wall is double, has ten-inch cavity with pumice insulation. Sketch shows sunlight angle of high summer (S) and low winter (W) sun.



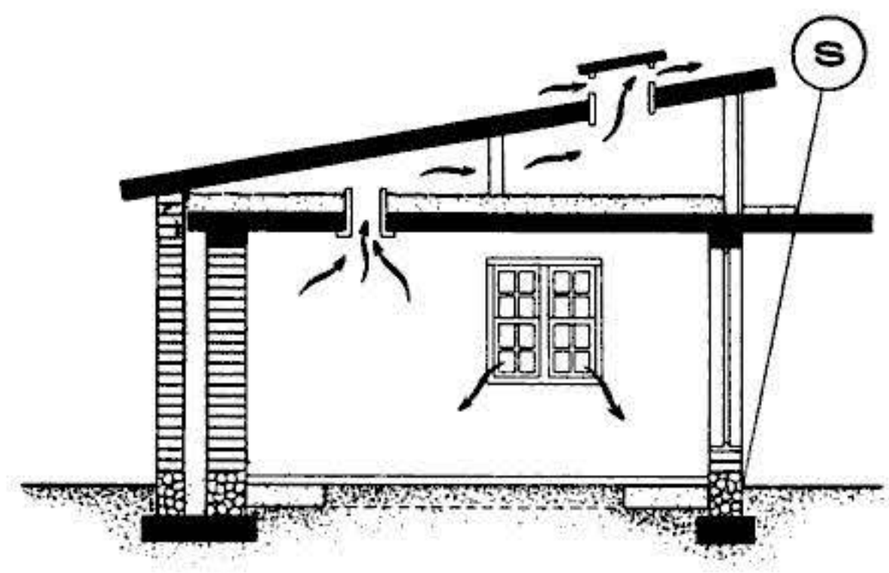
DIRECT-GAIN UNIT Large south-facing, double-glazed windows let winter sunshine drench heat-absorbing adobe walls and flagstone floors. Heavy curtains prevent heat loss at night. In summer, planks are placed on jutting *vigas* to shade out high sun.

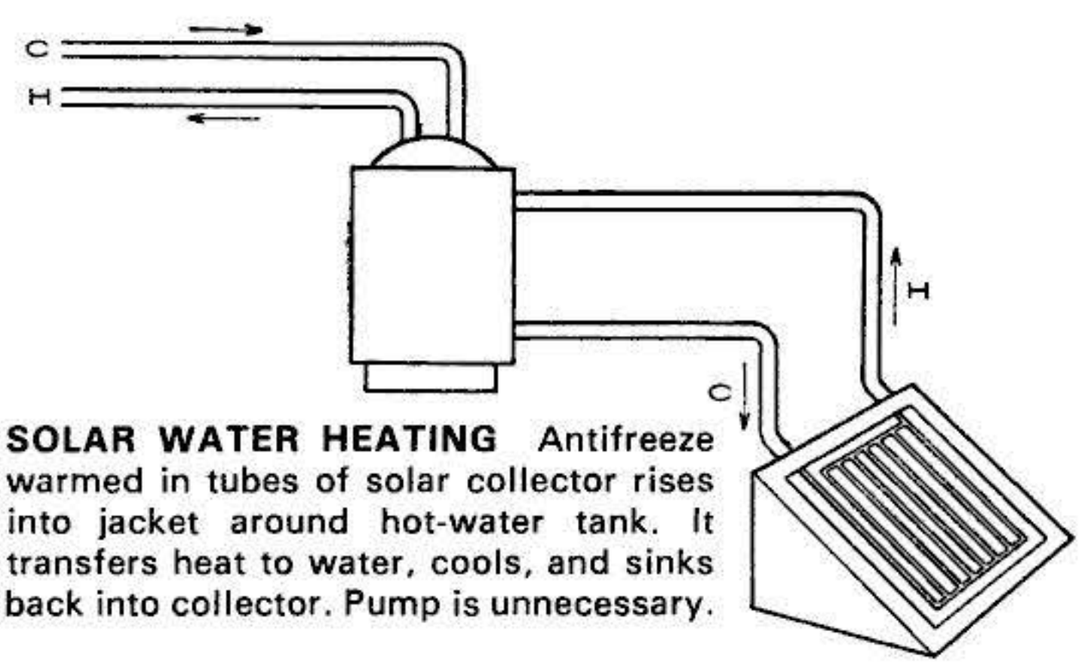


TROMBE WALL UNIT Dark, heat-absorbing Trombe wall is placed directly behind double-glazed windows. Sunshine heats surface of adobe Trombe; air in space between glass and wall expands and rises, entering room through upper vents. Cool air flows into gap through lower vents, creating circulation. Heat travels through wall and radiates into room at night.



PASSIVE COOLING AND VENTILATION Variable shading placed on overhang keeps out summer sun. Air in hot space between roof and insulated ceiling rises and exits through roof. When ceiling vents are opened, warm air in room is exhausted and cool air is pulled in through window, even on calm days.





SOLAR WATER HEATING Antifreeze warmed in tubes of solar collector rises into jacket around hot-water tank. It transfers heat to water, cools, and sinks back into collector. Pump is unnecessary.

each unit for the convenience of guests—if they need it. Thanksgiving weekend, 1976, saw outside temperatures sink to −19° F; inside it was 62° F.

Tentatively, engineers at LASL figure that the passive solar systems are capable of supplying roughly 50 percent of the total heat needs of these units in winter.

"The amount of glazing in these solar units equals about one-third of the floor area," Buck Rogers told me. "To reach a contribution of 70 percent of our heating from solar, we would probably have to have 50 percent of the floor area in glass."

"Don't forget costs," Aubrey Owen said before I left. "One of our aims was to show that low-cost, owner-built homes using cheap materials could be effective with these systems. Well, our purchased materials averaged less than $8000 per unit—less than $10 a square foot for the Sundwellings, including the collectors. We think that's pretty darn good." PS

FOR FURTHER READING

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Homegrown Sundwellings by Peter van Dresser. The Lightning Tree. P.O. Box 1837, Santa Fe, N.M. 87501.

Passive Solar Buildings: A Compilation of Data and Results (SAND 77-1204). Prepared by Sandia Laboratories, Albuquerque, N.M. 87115.

Solar Energy Handbook 1978. Published by *Popular Science.*

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Colored contact lens

helps correct color blindness

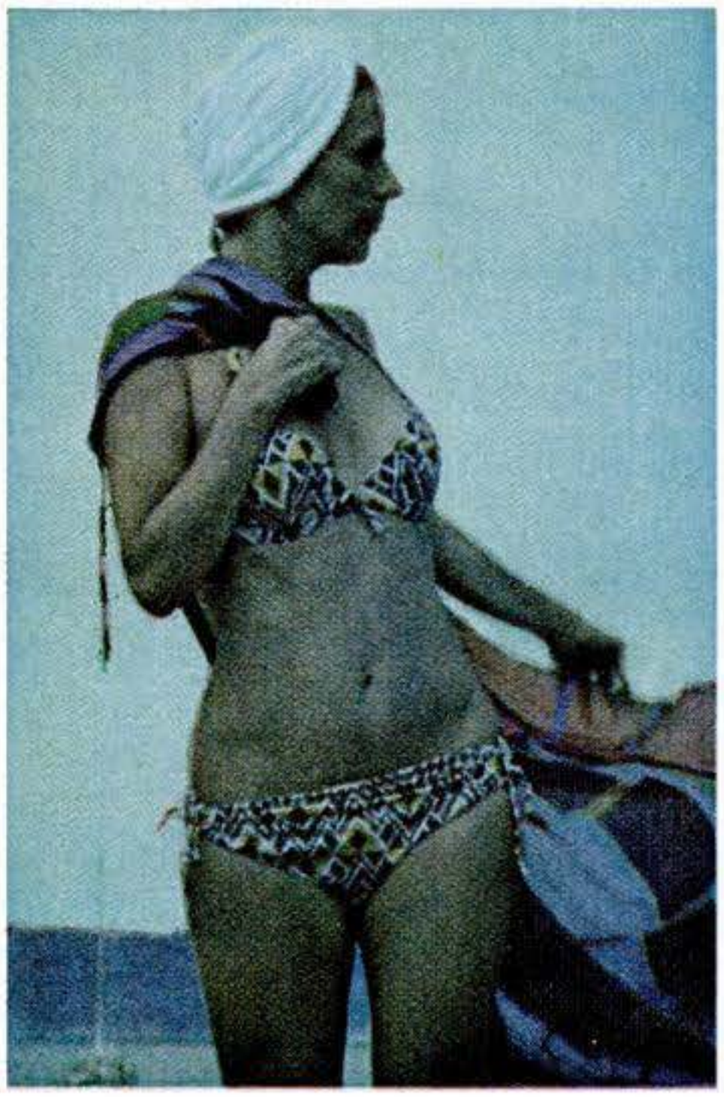
Color-correcting contact lens is worn in one eye only. It won't work if worn in two or if fitted into spectacles.

Raspberry-red contact lens, worn in one eye only, can improve perception for many with poor color vision

By DAVID R. ZIMMERMAN

On the West Coast, restrictions were lifted from a color-blind man's boat license—after he was fitted with a bright red contact lens. Back East, the Chesapeake and Potomac Telephone Co. and the New England Telephone Co.

What do color-blind people see? A normal-sighted person can't know for sure, but optometrist Zeltzer has developed a photographic process, using a special pinkish-green dielectric filter (from Spectrum System, div. of Valtec Corp., Waltham, Mass.) that he believes reproduces a scene on film roughly as the color-blind see it (top right). Compare that to normal color vision represented by the photo made without filter (bottom right). The filter blocks out light of the red-green part of the spectrum that most color-blind people have trouble seeing. Scene in the top photo appears too blue because there's no red light. (Photos by John Lind, X-Chrom Corp.)



A cosmetic problem for the wearer? Perhaps, but not necessarily. Close up, the two different "eye" colors are certainly noticeable, especially with green- or blue-eyed people (top). But our hazel-eyed executive editor, Ken Gilmore (bottom), put the red lens in his left eye and walked around the office asking PS staffers if they "noticed anything different" about him. No one did.

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hired color-blind men they had previously rejected—after the men were fitted with the red lens.

From the elementary-school classroom to electronics engineering, the world is becoming increasingly dependent on color coding. And that means the color blind are finding their opportunities more and more limited by their visual deficiency. But now, for the first time, color blindness can be at least partially corrected. A special raspberry-red hard contact lens, invented by Waltham, Mass., optometrist Harry I. Zeltzer, increases the range of colors a color-blind individual can detect. It works when worn in one eye, but—puzzlingly—not when worn in both. The red X-Chrom lens also can correct nearsightedness and other errors of refraction. The cost, says Zeltzer, is little more than that of ordinary hard contact lenses.

The new lens is named for the X, or female, chromosome, through which mothers transmit the recessive gene for color blindness to their sons. The mothers themselves are rarely afflicted, since their second X chromosome usually carries a dominant, normal gene for color vision. The result is that one in every dozen American males is color blind, while only one in every 200 females is afflicted.

The commonest form of color blindness is red-green color confusion. The English call it daltonism, after their great 18th century chemist John Dalton, who was one of the first to discover it—in himself. The person who suffers from it has impaired reception of red or green wavelengths of light. Reds are hard to distinguish from greens. Both may appear grayish and look like browns and blues.

It really works

Much experimental work still must be done to find out how and why the red lens helps overcome color deficiency and to delineate its benefits and shortcomings. Nevertheless, early published assessments, including some from the armed forces, indicate that it significantly improves wearers' abilities to identify varied hues of color, compare colors, and see colored objects. The American Optometric Association foresees a "very promising" future for the lens.

Two Army optometrists who studied the lens say: "We have been able to improve performance on color-vision tests and in the practical situation of identifying different colored objects correctly."

While only four of the 10 Army reservists in these tests achieved all-day wear and continued to use the lens when the tests were over, Maj. Dennis Ditmars and Capt. Roderick Keener of San Francisco reported almost a 50 percent overall improvement for all 10 men on color-vision tests.

The men said the lens made their visual worlds more attractive and safer, too. "I can appreciate art work better," one remarked. "I can pick out the proper colored clothing on a store clothes rack," said another. A third declared, "I see red auto tail lights, brake lights, and turn signals more brightly now."

The X-Chrom lens will not help everyone who has trouble seeing colors. Some people simply cannot or do not want to wear contact lenses—and the method does not work when the red filter is mounted in the lens of ordinary glasses. Other people, Zeltzer says, are unwilling or unable to use the lens to learn to see new colors.

> "I can see red auto tail lights, brake lights, and turn signals more brightly now"

Because it reduces the total amount of light reaching the retina, the X-Chrom is difficult to use at night. There also may be a cosmetic problem, for while the lens is fairly well concealed against a brown or hazel iris, it shows up red or brown on a green eye and may appear red on a blue one.

How the lens works remains uncertain, which is not surprising, since the nature of the physiologic defect in color blindness remains unclear. What is known is that an X-Chrom lens, a red filter, absorbs most blue light, much green, and some brown. But it admits most browns and reds, colors in the red zone of the spectrum between about 590 and 700 nanometers.

Inventor Zeltzer has a tentative explanation as to why this helps correct color blindness: "When a person wears the lens, he will perceive some colors correctly through the naked eye—blues, for example, if he is red-green color blind—but other colors, for which he has a color deficiency, will be confused. The brain learns to recognize this confusion, and shifts to the eye with the lens. These colors are comparably enhanced by the lens, and so appear brighter.

Visual information

"This increases the color values of what for the uncovered eye were confused colors, and also makes objects of these colors stand out against backgrounds with which they previously blended. The corrected eye sees the colors, while the background may be perceived by the naked eye. This increases the contrast. The mind, then, continuously selects that set of impulses, from one or both eyes, that delivers the most visual information."

Eric Rosenfield, an electrical engineer from Marlboro, Mass., relates his experiences as an X-Chrom lens wearer: "As I became aware of this visual assembly process, I realized that there was a predictable system whereby the mind decided to accept the color sensations from one or the other of my eyes. And the total perception was assembled from those pieces of each visual field so as to provide the maximum information about the objects."

"The changes in vision caused by the X-Chrom lens," explains Zeltzer, "enables the person to make a greater number of color comparisons than he could without it, and also increase his sensitivity to color. This sensitivity is a learned attribute that increases with time—up to about six months of use. The increased sensitivity, in turn, stimulates the identification of a greater number of colors by name." A normal person typically distinguishes 150 hues, Zeltzer says, while a color-blind person may see only 75. The X-Chrom lens may increase that to 130 hues.

But exactly *what* colors do wearers of the red lens see? There is no easy answer because there is no human "language" of color. That is, there is no way for one person to know what another is seeing when he looks at the lawn and says, "The grass is green." So Zeltzer does not know what lens wearers are seeing. But he thinks they are not simply seeing more shades of grey. Rather, he believes that they see hues that are new for them and similar but not identical to hues seen by normal-sighted persons. "They're not seeing it the way you or I see it. They're perceiving new colors!" PS

FOR FURTHER INFORMATION:
Your ophthalmologist or optometrist can obtain technical information about the X-Chrom lens or the lens itself from X-Chrom Corp., 6 Beacon St., Boston, Mass. 02108.

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Wingless plane

—strange relative of the Space Shuttle

Simple controls and roomy body—is it a new flying shape we'll see in the '80's?

By BEN KOCIVAR

MOJAVE, CALIF.

At 5000 feet, our Cessna 172 throttled back, banked, then dipped below the strange-looking flying machine. I was trying to get a good shot for this month's PS cover. As I aimed my camera up through the windshield, all I could think was: "It looks like a prop-driven barn door."

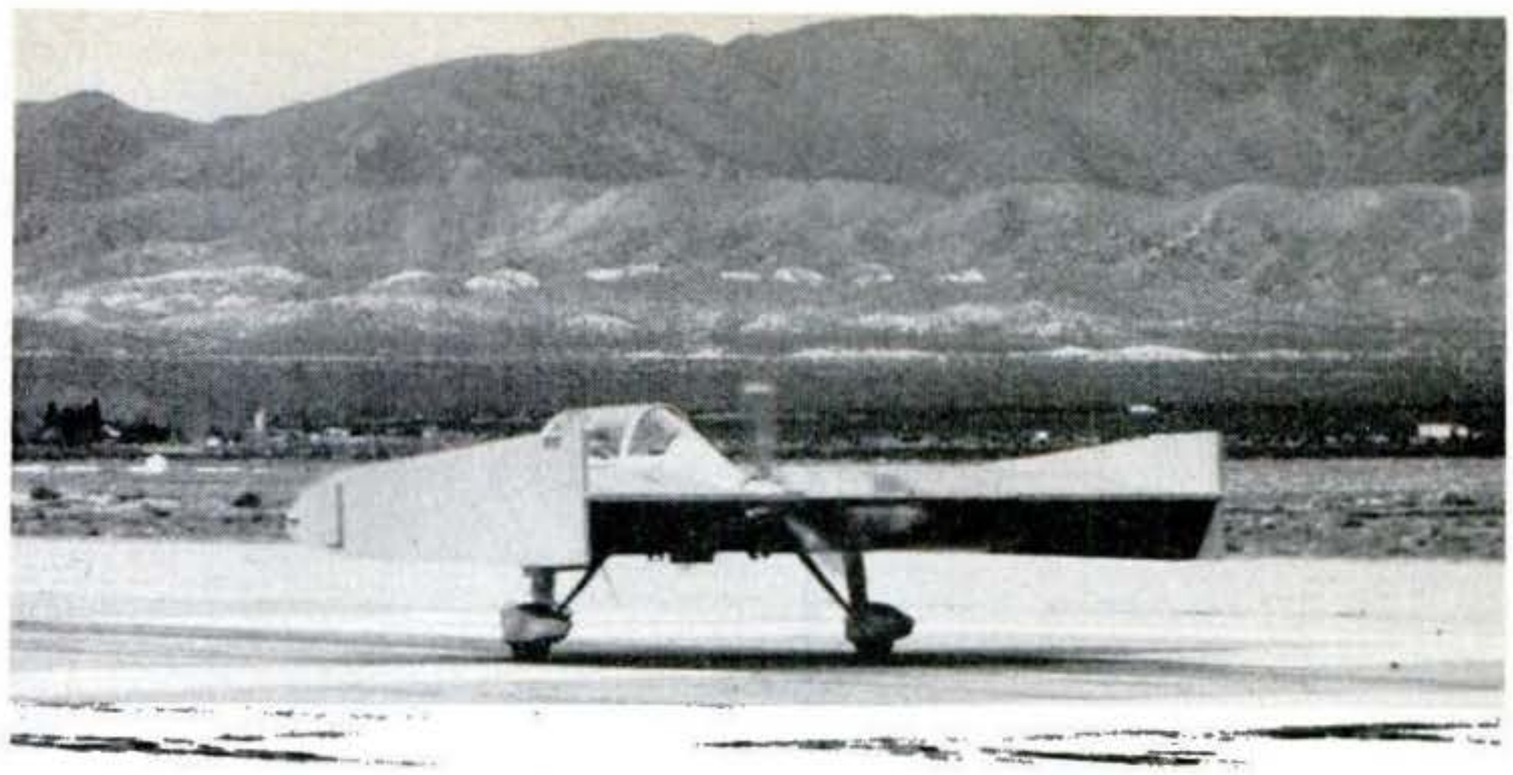
The inventor, Ralph W. Sawyer, claims it's the only true lifting body functioning in the world today. That's what first intrigued me when I heard about the wingless plane. Research on lifting bodies began in the early '60's, when NASA started planning the Space Shuttle (see box, p. 84). But Sawyer is probably the only one who's applied the lifting-body concept to airplane design. He sees his wingless plane as the forerunner of a whole new class of airplanes that would be cheap to build, easy to maintain, and docile to fly. As a bonus, he says, his design should carry 4½ times more load than an ordinary plane with the same span.

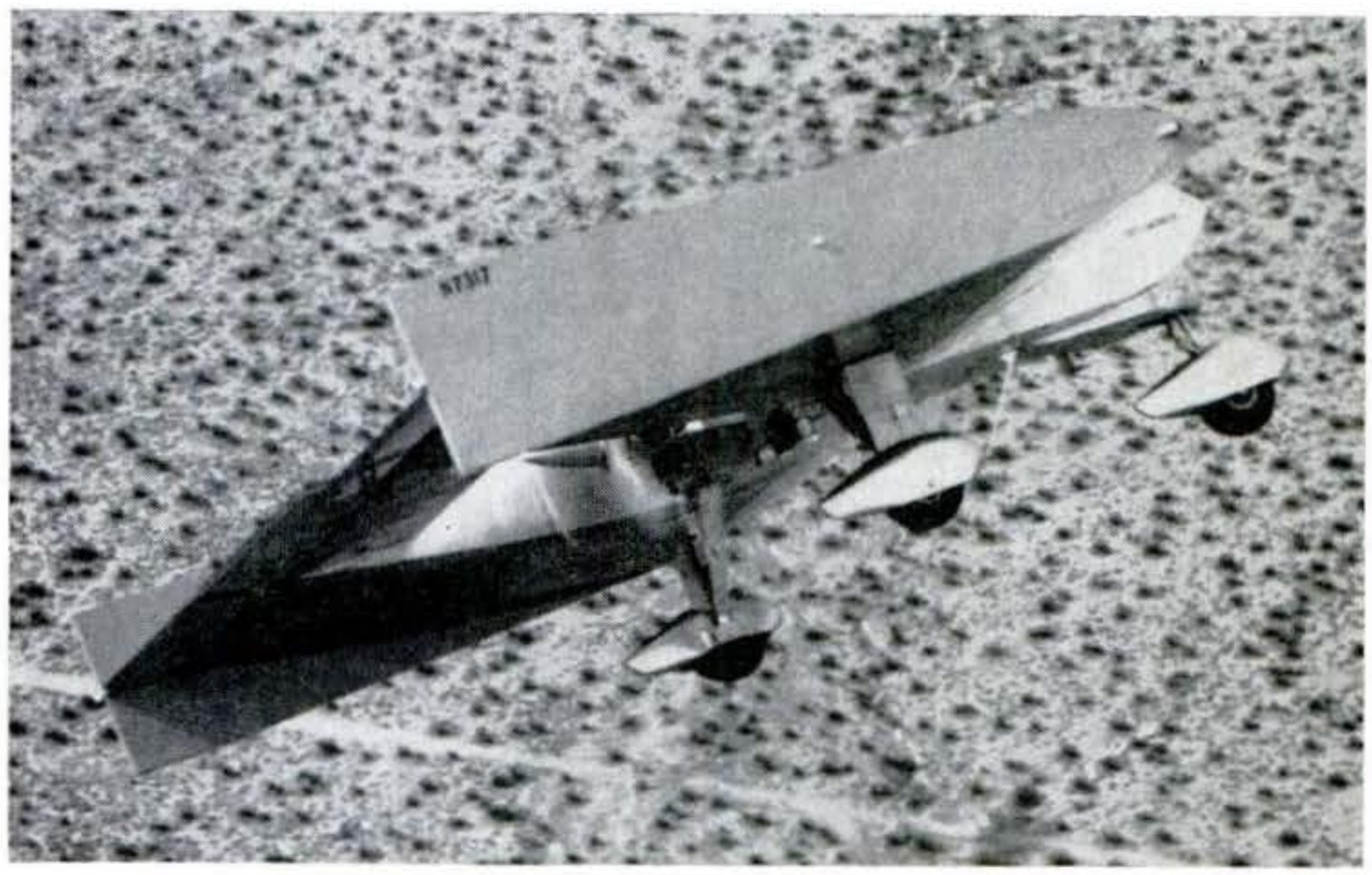
I've heard claims like this before. But there was another reason I wanted to see Sawyer's aircraft. When I was a kid building model planes, I heard about the Burnelli transport [PS, Nov. '45]. Inspired, I built what was a kind of lifting body—a three-foot-square balsa-frame airfoil, with two props powered by rubber band motors. With some winglets added, the thing flew. So I was curious to see how Sawyer's non-winged 18-foot-square airfoil would perform.

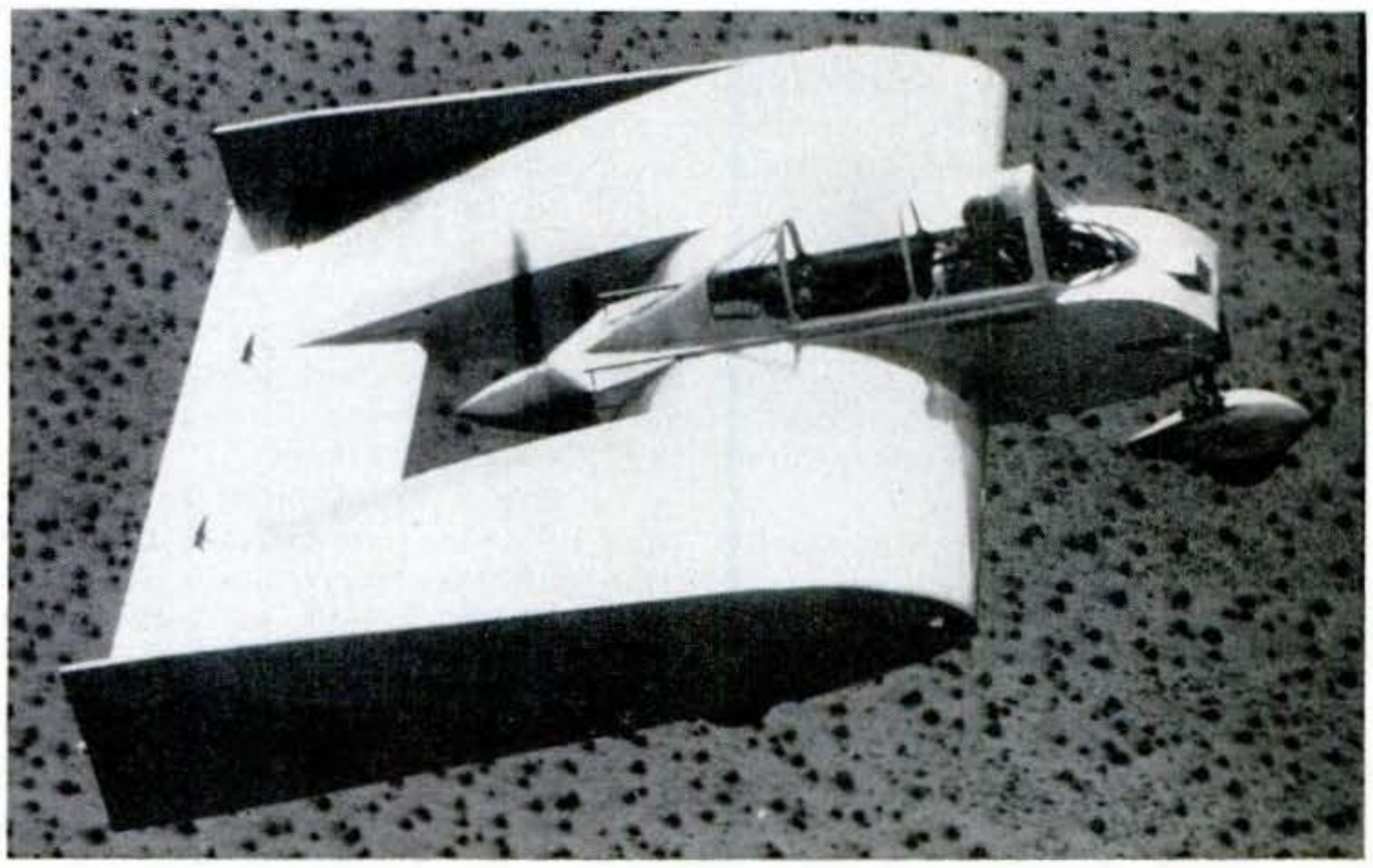
Sawyer is the inventor, builder, and test pilot. As a flight-control and electronic technician at NASA's Dryden Flight Test Center, he worked on the lifting bodies that led to the Space Shuttle. His extensive technical and practical knowledge shows up in his plane's design.

A quiet, dedicated man, he's deeply committed to the idea of a practical lifting body. "This is my first manned version," he said, "but I've built four unmanned ones, ranging

Without wings (left), the unique plane chugs aloft, powered by a rear-mounted prop centered in the slot between airfoils. The small yaw door near the front of the left end plate is slightly open, helping to straighten out the plane during crosswind takeoff (top right). The doors are closed in flight, even during a steep turn (second photo). As seen from above (third photo), Skyjacker has four airfoil-shaped parts: the cockpit; the curved members close to the sides of the cockpit; the panel behind the prop; and the main lifting foils, each bordered by the end plates. At bottom, author Kocivar inspects an aileron.







from a simple 12-inch cardboard glider through a six-foot, radio-controlled, two-engine craft." He's already invested about $100,000 in the project, he told me.

Though the latest version is a two-seater, it has only 16 flight hours; he hasn't yet taken up a passenger. Sawyer calls it Skyjacker "because it jacks itself into the sky."

As I watched his takeoff, I saw his point. After running about 1200 feet down the runway, he yanked back on the stick, and the plane leaped quite abruptly into the air.

Even with its 200-hp engine and constant-speed, three-blade prop, however, Skyjacker didn't exactly reach for the sky after takeoff. Climb rate was only about 250 feet per minute at 75 mph—much slower than a 100-hp Cessna 150.

But as we flew in formation in quite gusty conditions, the plane seemed to verify Sawyer's claims for unusual stability. It flew with its nose rather high up, like a delta-wing design.

Since the craft is experimental, we flew a loose square pattern around the airport. To get good pictures, we had to search for sunny holes in the clouds—so there was constant maneuvering. Though Sawyer is not a high-time pilot, he made some remarkably tight turns. Once he banked so steeply that he was partially inverted for a moment. The turns were even more impressive because Skyjacker has no rudder. On conventional planes, you need the rudder to correct for the sideways yaw that occurs when you bank the plane.

Back on the ground, I asked Sawyer about this. "I simply bank, pull the stick back, and around I go," he said. "The plane's low-aspect ratio makes it less sensitive to big center-of-gravity changes than conventional planes."

Low-aspect ratio means the

Continued

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wingspan is unusually short compared to the chord—the distance lengthwise from the leading to the trailing edge. A conventional four-seater might have a 32-foot wingspan and a five-foot chord. Sawyer's plane is 18 feet across and 18 feet long from the tip of the cockpit to the trailing edge.

Sawyer carefully designed his wingless craft to get as much lift as possible cheaply. There are not one, but four airfoil shapes in the lifting body (see photo). The 14-foot-long, orange end plates are another innovative touch. "They provide directional stability," Sawyer told me, "and increase lift by preventing spanwise airflow that normally spills off wingtips."

The propeller's position at the rear is also carefully planned. Because it sucks air back over the center at a faster speed than normal airflow, the prop provides better laminar flow (good lift) especially at slow speeds. This greatly improves stability at slow speeds that might cause other planes to stall and spin.

The design makes the plane easy to fly. "Even in turbulence," Sawyer said, "it feels like you're on railroad tracks. And the plane practically lands itself."

Other advantages Sawyer mentioned:

- The plane lends itself to low-cost construction because it has no compound curves and no tapered spanwise sections. "Basically, it's built like an egg crate," he said, "with aluminum panels laid over built-up ribs."
- It is cheaper and easier to maintain because it has no complicated flaps and no spoilers.
- Its unusually thick lifting body is 15 percent of the chord—much thicker than conventional wings.
- Its flight controls are basically simple—a stick, and a foot pedal that controls the nose wheel and yaw panels.

Sawyer admits that his first plane does not perform impressively. The fastest he's flown it has been about 150 mph indicated airspeed in a slight dive. Flying level at full-speed power, he does 107 mph; he cruises at 95 mph with 75 percent power; touchdown speed is 65 mph with power, 75 mph without. But Sawyer points out that Skyjacker's speed, climb rate, and other performance figures do not reflect its true potential. For one thing, Skyjacker is rather heavily constructed; it weighs 2150 pounds with its 200-pound pilot and 25 gallons of fuel on board.

Ready for takeoff, Sawyer grasps control stick. It features an electric trim button that controls two servo motors, which adjust ailerons for pitch and roll.

But this is really a proof-of-concept airplane, rather than a true prototype. If it were a major manufacturer's project, odds are that this first man-powered version would not be publicized at all.

Sawyer's next goal? Getting financing to build a double-sized, 36-foot prototype, powered by two turboprop engines. This one would have no nose section sticking out, and pilot and passengers would be completely enclosed in the lifting body. He believes it could carry fuel for 4000-5000 miles.

Getting a prototype approved by the FAA for commercial production will take much more money. Ralph Hare, chief of the FAA branch that certificates new airplanes, told me: "Certification of a radical new light plane design could cost as much as 1½ to two million dollars and could take as long as two years." These big numbers are the obvious reason you don't see many really new designs coming off the production lines.

If it should get to the certification state, can the lifting body fulfill Sawyer's claims? Several experts in aerodynamics told me there are some good arguments in his favor:

- Compactness. The plane could take off, park, and taxi in restricted, narrow areas.
- Lower weight. The thick wing permits use of lightweight girder construction.
- Possible lower cost. This would depend on the quantity and manufacturing methods.
- Potential future development of a new STOL design using the same propeller placement but incorporating high-lift devices such as in the YC-14 and YC-15 [PS, Feb. 76, Nov. '77].

Their reservations?

- Research has proven that in low-aspect-ratio designs the drag due to lift (induced drag) is worse than in a high-aspect-ratio design. This is why high-performance sailplanes have long, slim wings.

True, the Concorde and some supersonic fighters have low aspect-ratio designs. But the narrow wingspan is not as much of a handicap when you start flying above 400-500 mph. This takes tremendous amounts of costly power, however.

- Skyjacker's low climb rate is a symptom of high drag. Its ability to climb depends on having excess horsepower for the speeds it produces.

Almost everybody agreed that Sawyer is researching an area that needs exploring. If Sawyer's on the right track, we may see some radically different new airplanes in in the next decade. PS

Flying wings are not wingless planes

From the 1920's through the 1940's, Vincent Burnelli developed his "modified flying wing"—a conventional plane with a broad airfoil-shaped fuselage. The design gave more cargo space, and, he said, greater lift. Today, some hang gliders, a few sailplanes, and experimental craft like the old YB-49 jet prototype, are true flying wings—planes with no tail section, but with large wingspans. Flying wings have a good lift-to-drag (L/D) ratio, which is essentially the same as the glide angle—that is, the distance a craft will travel forward compared to the distance it drops down. A really good sailplane might have an L/D ratio of 45:1. Such a ratio gives a plane a flat rather than a steep glide.

While flying wings were developed as alternatives to conventional planes, lifting bodies were originally meant to be improved spacecraft. For the Space Shuttle, NASA needed a craft that could withstand the heat of reentry from space, but that also could be maneuvered in the earth's atmosphere. A wingless craft would spread the heat load—but would have a very restricted gliding range. A number of pre-Shuttle designs, such as the M2-F2 and the X-24A, were pure lifting bodies. The X-24B [PS, Nov. '73] had small winglets, so some considered this a winged plane, like the Shuttle. A pure lifting body would have served NASA missions, but the Air Force needed more flexibility in choice of landing sites. A wingless Shuttle would have a very steep glide; wings improve its L/D ratio, increasing its glide range.

Some experts consider Sawyer's Skyjacker just a flying wing with a foreshortened wingspan. But he insists that its square shape (low-aspect ratio) and thick body make Skyjacker a true lifting body—thus a radical new aircraft design.

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Run-flat tire
eliminates the spare

By RICH CEPPOS

The driver in the car beside me honked his horn excitedly, while pointing at my front tire and mouthing the word "flat." I waved thanks and continued without concern up New York City's Eighth Avenue at speeds of up to 35 mph. The reason for my lack of concern: I was testing one of Goodyear's new flat-proof tires that seem destined to usher in a new era of driving without the spare tire.

The only thing I noticed with the "flat" tire was a slight pulling to the right and a snow-tire-like hum coming from the front. Though completely unpressurized (I witnessed the valve being removed), the tire didn't flap itself into shreds or shake the car to pieces.

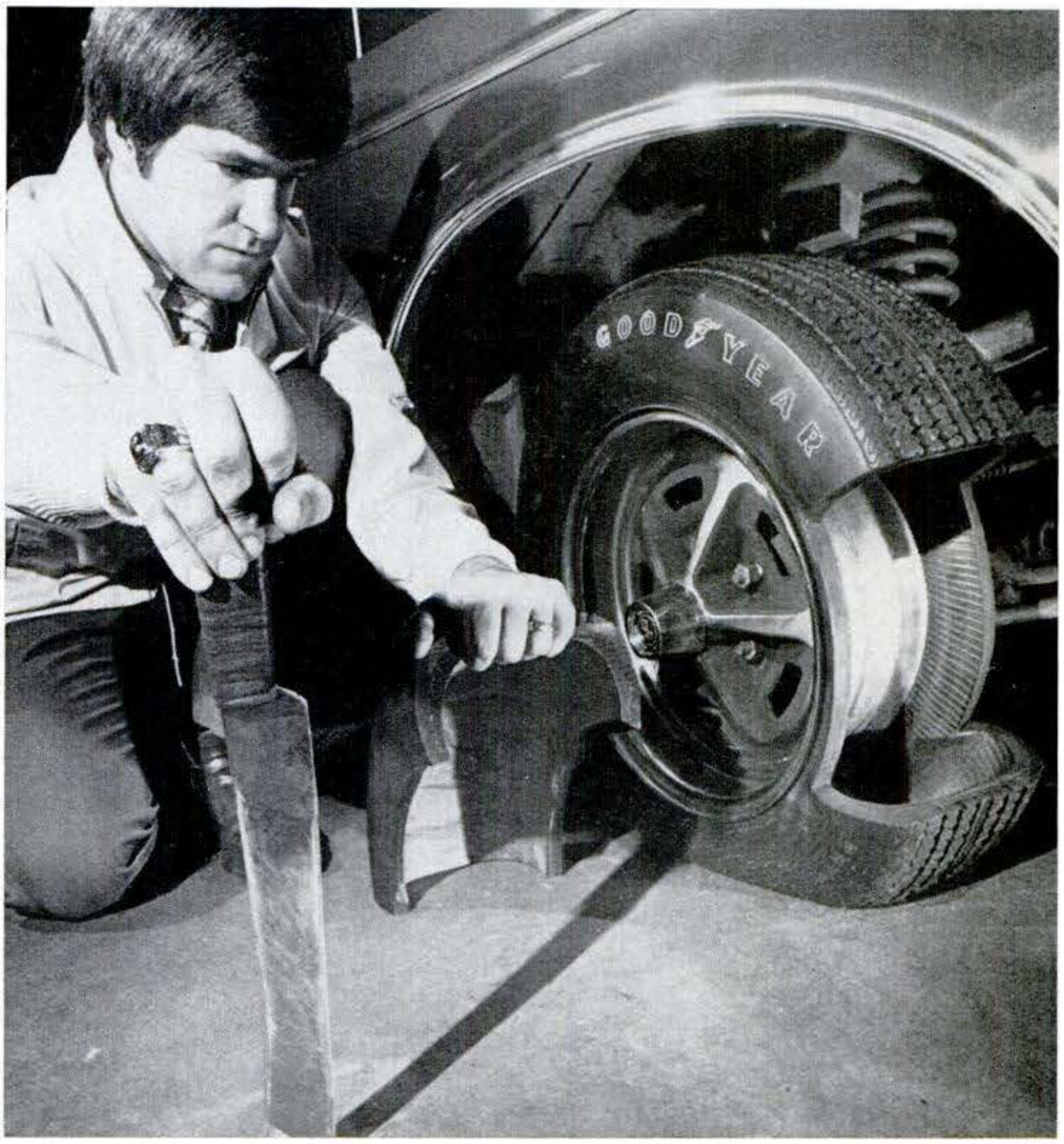
Run-flat tires are not new, but the Goodyear version is different from past designs. It works without an inner liner, internal sealant, foam-filling, or a special rim. For those reasons, plus the fact that it can save an estimated average of 18-22 pounds per car, the Goodyear flat-proof may finally eliminate the spare tire in new cars.

A unique sidewall is the key element in the Goodyear design. "The sidewalls are about three times as thick as those on a normal radial tire," says Mark Mineur, a Goodyear development engineer on the project. "When they deflate, the weight of the car is supported solely by the sidewalls.

"The biggest problem that prevented us from using this design before was heat buildup. When the tire runs flat, the thick sidewall flexes and gets very hot, which can destroy the tire."

The solution? "We developed a brand-new rubber compound for the sidewall. It's stiffer than the normal sidewall rubber, but it runs cooler. It also resists the effects of heat better than the classic sidewall rubber compound." The composition of the new sidewall compound is proprietary; Goodyear won't say what makes it different.

The sidewall's construction is also novel in another way. "Most tires use two layers of rubber," says Mineur, "one on the outside and one for the inner lining. In the flat-proof, we sandwiched the special heat-resistant compound between the normal inner and outer sidewalls, because it doesn't work as well as the regular sidewall materials do in those positions."



Sidewalls of Goodyear flat-proof radial (lower photo) are three times thicker than conventional tires; they support car even with section cut out. Unpressurized flat-proof tire (top photo) is shown in PS test drive.

Despite the flat-proof's new compound, heat buildup still limits how far you can drive it flat. Goodyear officially recommends a maximum flat-driving limit of 40 miles at 40 mph. "But we've run them farther in tests," says Mineur. "It all depends on the ambient temperature. The cooler it is outside, the cooler your tires will run, so the longer they go. We figured the 40/40 limit for approximately 80-degree heat. On a cold day, say in the 20's, you could go much farther —maybe 60-65 miles. And if you need extra range on a hot day, you could slow down to 30 mph. This also reduces heat." You can run the flat-proof the maximum mileage every time it goes flat, not just once.

Other than the sidewalls, the tire's construction is conventional. It uses steel belts and polyester cord just like the Goodyear Polysteel radial, and the tread pattern is a standard design. As a result, "the handling, wear rate, and ride are about the same as with a normal tire," claims Mineur.

Goodyear-developed deflation sensors must be installed with ev-

[Continued on page 184]

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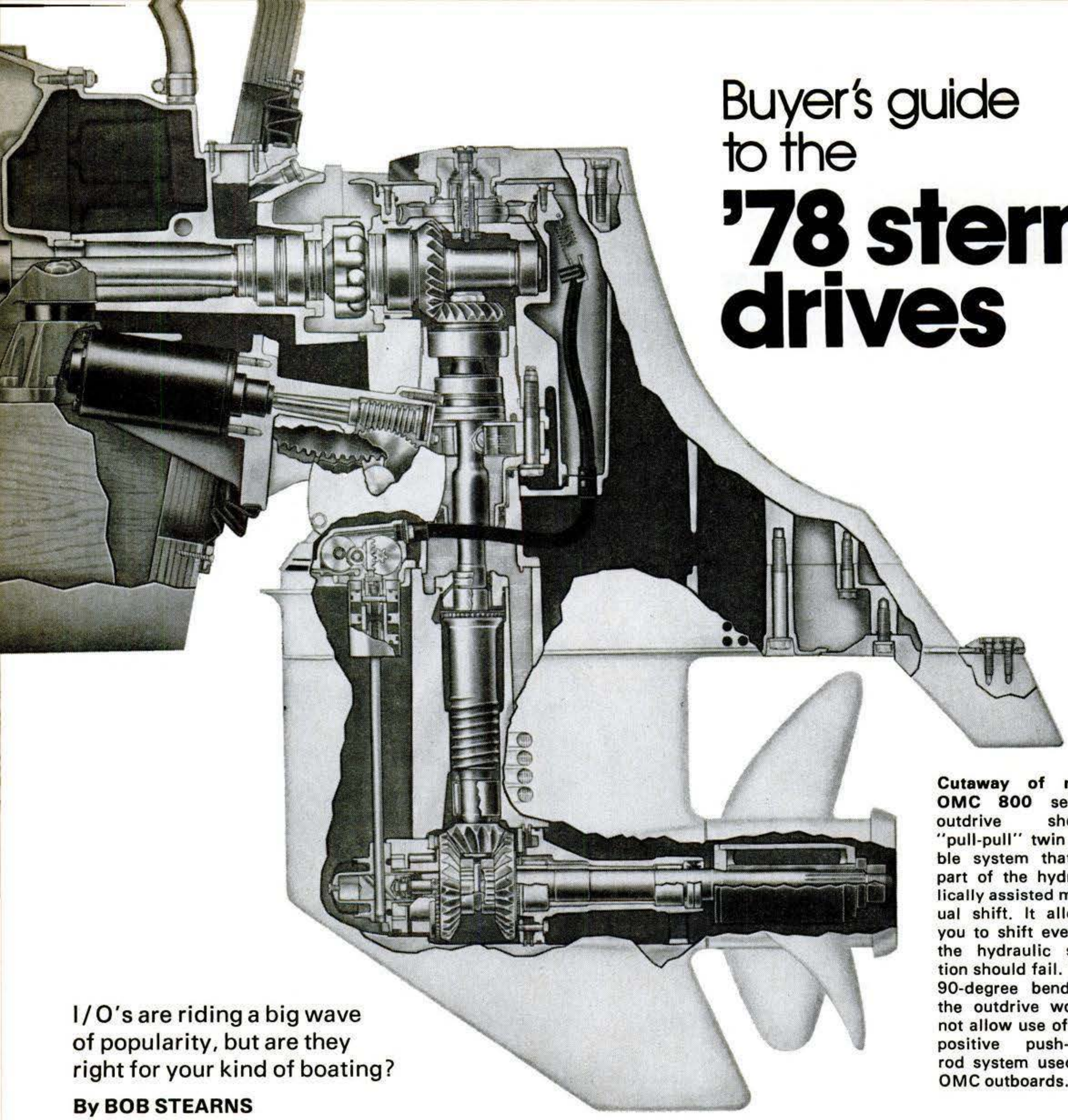
Buyer's guide to the '78 stern-drives



Cutaway of new OMC 800 series outdrive shows "pull-pull" twin cable system that is part of the hydraulically assisted manual shift. It allows you to shift even if the hydraulic section should fail. The 90-degree bend in the outdrive would not allow use of the positive push-pull rod system used in OMC outboards.

I/O's are riding a big wave of popularity, but are they right for your kind of boating?

By BOB STEARNS

The growing popularity of big boats has created a boom in stern-drive engine sales. And if you're thinking of buying a boat that's 20 feet long or bigger, a stern-drive may be your best bet for power.

Stern-drives, also called inboard/outdrives, or simply I/O's, have been around since 1931. But it wasn't until the boat trailer boom of the early '60's that they came into their own. Nearly 100,000 I/O's were sold last year and about that many will be sold in '78, according to industry sources.

There are four major makers of gasoline-fueled I/O's: Chrysler, Mercury, Outboard Marine Corp., and Volvo Penta. Let's take a look at what they'll be offering this season.

Chrysler

"You won't be able to see a great difference between this year's line and last year's," a Chrysler stern-drive engineer told me recently. "Externally they look much the same. But inside, there are a lot of refinements you can't see, such as a more extensive use of stainless steel in corrosion-critical areas."

The heart of Chrysler's I/O system is the "300" outdrive, first introduced last year and improved for '78 with further engineering refinements. Three V8 engines will be available with the "300" again this year: 195, 240, and 265 hp.

Chrysler's "old reliable" 318-cu.-in.-displacement V8 engine is the basic block for the 195 and 240. "The 195," says Chrysler's Bill Maxwell, "is conservatively rated at 195 horsepower. Dynamometer tests have shown that it can actually produce more than 210 horsepower. This means fast acceleration as well as power to lug big loads."

The 240-hp version of the 318-c.i.d. develops the extra power by four-barrel carburetion, an 8.8:1 compression ratio, electronic ignition, high-lift cam, and stellite-faced exhaust valves with positive rotors. The same basic refinements

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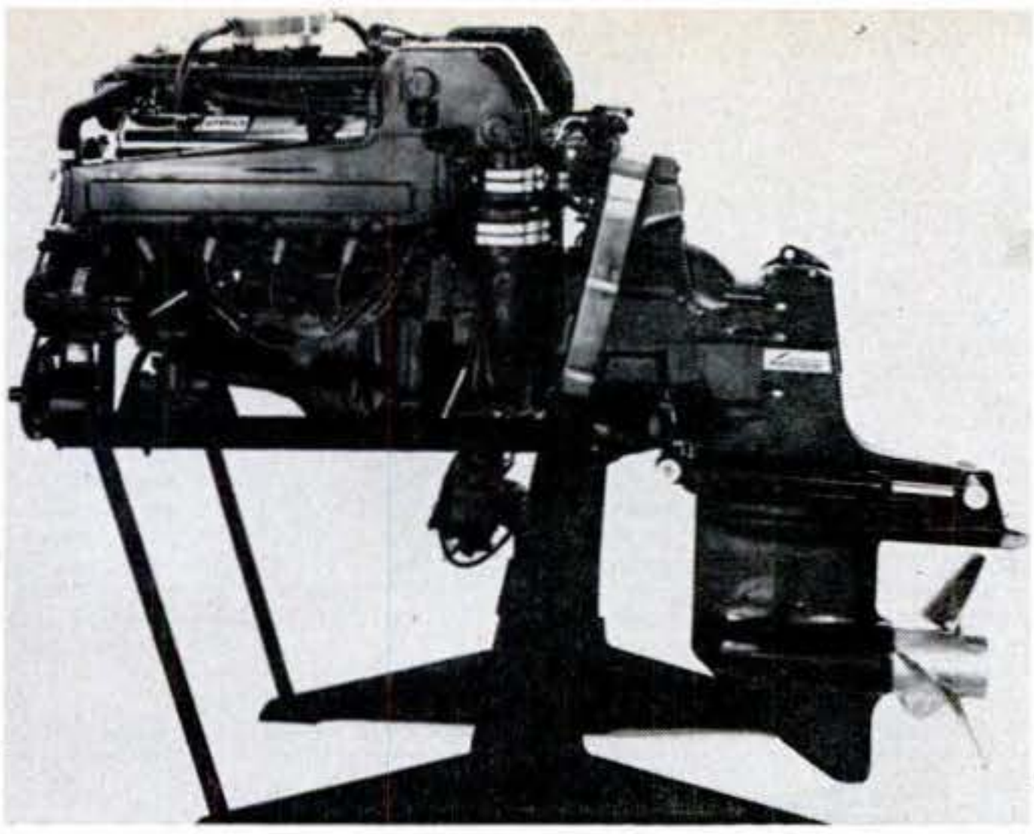

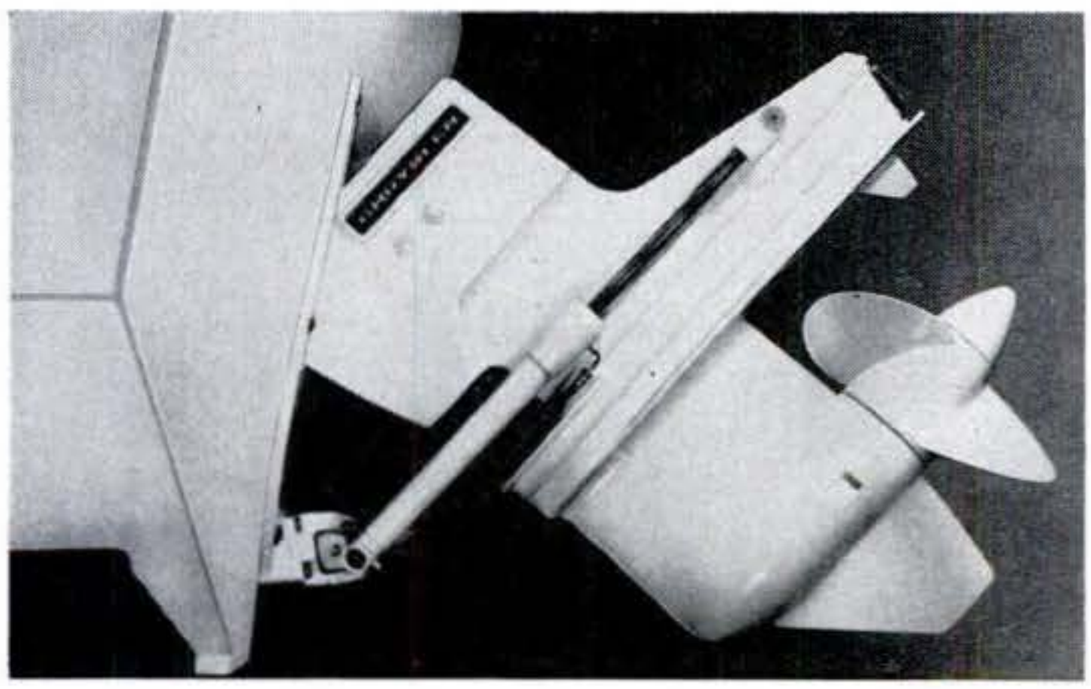

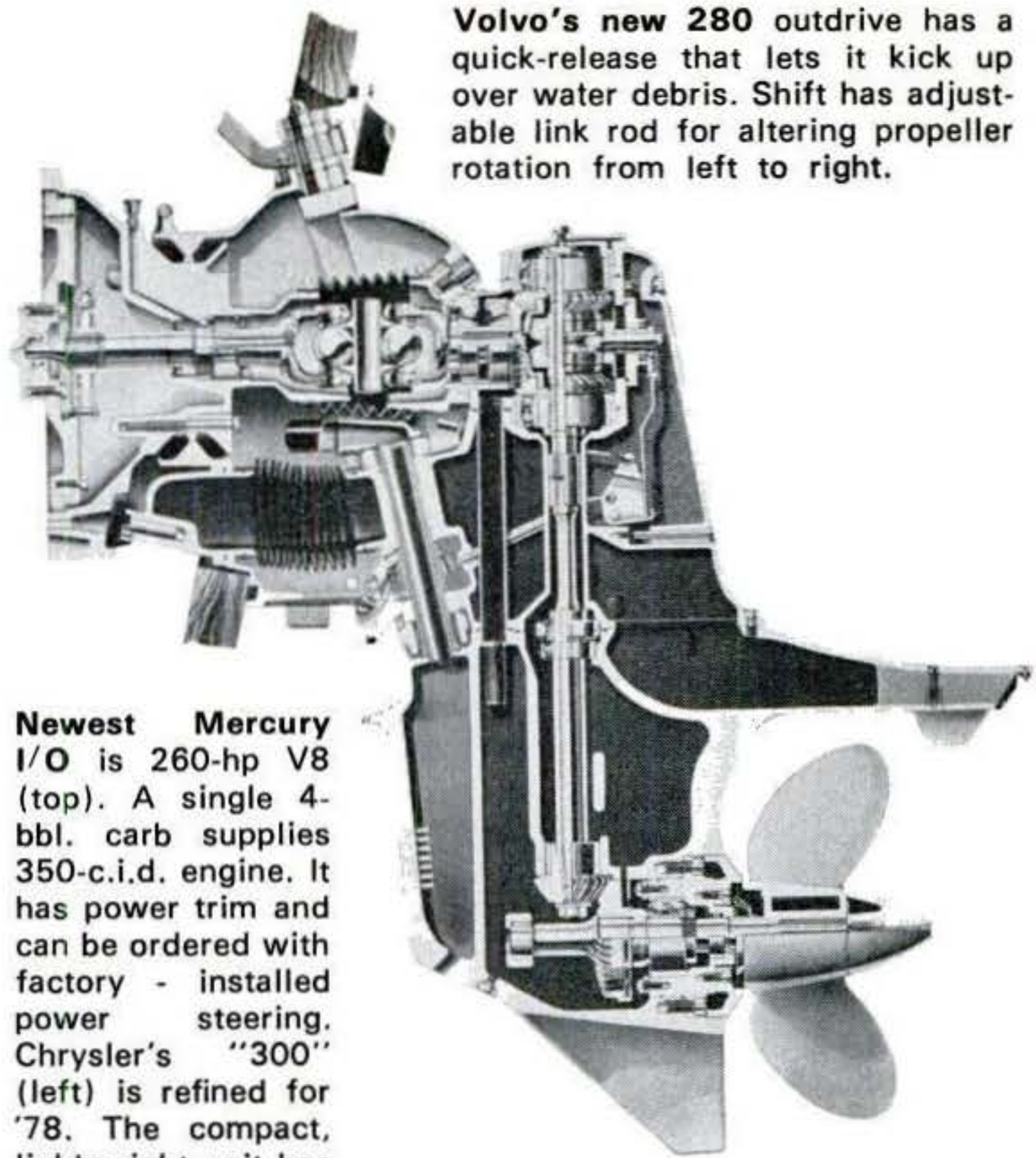

Volvo's new 280 outdrive has a quick-release that lets it kick up over water debris. Shift has adjustable link rod for altering propeller rotation from left to right.

Newest Mercury I/O is 260-hp V8 (top). A single 4-bbl. carb supplies 350-c.i.d. engine. It has power trim and can be ordered with factory - installed power steering. Chrysler's "300" (left) is refined for '78. The compact, lightweight unit has an "inverted yoke" suspension that Chrysler claims improves steering, handling.

are used to produce 265 hp from the 360-c.i.d. engine.

MerCruiser

The newest addition to Mercury Marine's MerCruiser stern-drive line is a 260-hp V8. Actually it's last year's 250, which used the same basic 350-c.i.d. block. A few refinements have been made to gain an extra 10 hp and improved fuel economy.

There are a total of six I/O's in Mercury's line, ranging from a 120-hp four in-line to a 330-hp V8.

Merc's lightweight (677 lbs.) four-cylinder 470, which develops 170 hp from 224 c.i.d., will be available again this year. It has no drive belts. Everything is gear driven (in this respect like most diesels). Fresh-water cooling is standard, and the block is all aluminum. More and more bass-boat builders are using this engine because of its light weight and excellent low-end torque for getting on plane quickly.

The most popular MerCruiser in overall use remains the 898. Its 198 hp is developed from a relatively small (305 cu. in.) displacement and at 872 lbs. it's suitable for a wide range of boat sizes.

If you wish to power houseboats and large cruisers, says Merc, then you might take a look at the MerCruiser 228TR and 330TR at 228 and 330 hp. A longer lower-unit gearcase on these two makes them capable of accepting propeller diameters up to 20 inches.

Merc claims to have the only true marine power steering, and it's standard on both the TR and TRS versions of the 330. It's also available as a factory-installed option on all other models in the line.

OMC

The big news from Outboard Marine Corporation's Stern Drive Division is its fourth generation of I/O's. They originate from a somewhat unlikely source: outboard motors. OMC makes Evinrude and Johnson outboards. The "400" series was developed from the lower-unit gearcase of the V4 outboards (85-140 hp), and is designed for use with OMC's two four-cylinder stern-drive engines. The "800" series has its origin in the lower-unit gearcase of the V6 outboards (175-235 hp).

Although not all of the inner gears are interchangeable with OMC outboard parts (different gear ratios are used, for example), most are—and this should greatly increase the availability of parts to the stern-drive user.

Some intense engineering went into the development of both V4 and V6 gearcases. They have proven tough, reliable, and unusually steady at speeds over 60 mph on the outboards, so it should be reasonable to expect the same for the stern-drive versions.

Further engineering was necessary to adapt these lower units to I/O use. A new upper outdrive housing had to be designed to mate with the outboard gearcases. Also, OMC wanted to have the same positive-action gearshift system for the new stern-drive system that it has on the current outboards: a hydraulically assisted manual shift system. Thus, if the hydraulic section should fail, shifting would still be possible via the positive action of direct mechanical linkage.

OMC accomplished this via a "pull-pull" twin stainless-steel cable system, since the 90-degree bend in the outdrive would not allow use of the same positive push-pull rod system used in its outboards.

According to OMC's Chuck Marcussen, "these new outdrive systems show a significant performance improvement because of the hydrodynamically designed shape of their lower gearcases and increased number of propeller options available."

Since they are identical to the outboard versions, the new outdrive gearcases also use the same through-hub-exhaust props as the outboards.

Continued

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1978 STERN-DRIVES—GASOLINE

Make	Model	No. cyl.	Hp	@	rpm	C.i.d.	Wt.	Gear ratio	Reverse rotation?	Max. prop. dia. (in.)	Red. gear location	Clutch type	Clutch location	Tilt means	Power trim?	Max. tilt, deg.	Other features
Chrysler	LM 318 AC	V8	195	@	4200	318	930	1.5, 1.75:1	Yes	16	Upper unit	Cone	Input shaft	Hyd.	Yes	52	
	LM 318 BC	V8	240	@	4600	318	931	1.5, 1.75:1	Yes	16	Upper unit	Cone	Input shaft	Hyd.	Yes	52	Electronic ign.
	M 360 BC	V8	265	@	4600	360	948	1.5:1	Yes	16	Upper unit	Cone	Input shaft	Hyd.	Yes	52	Electronic ign.
Mercury	120	4	120	@	3900	153	562	1.98:1	No	16	Upper unit	Dog	Lower unit	Hyd.	Yes	53	
	140	4	140	@	4200	181	588	1.98:1	No	16	Upper unit	Dog	Lower unit	Hyd.	Yes	53	
	165	6	165	@	3900	250	715	1.65:1	No	16	Upper unit	Dog	Lower unit	Hyd.	Yes	53	
	470	4	170	@	3800	224	677	1.84:1	No	16	Upper unit	Dog	Lower unit	Hyd.	Yes	53	
	898	V8	198	@	3800	305	872	1.50:1	No	16	Upper unit	Dog	Lower unit	Hyd.	Yes	53	Opt. power steering
	228	V8	228	@	4200	305	879	1.50:1	No	16	Upper unit	Dog	Lower unit	Hyd.	Yes	53	Opt. power steering
	260	V8	260	@	4200	350	891	1.50:1	No	16	Upper unit	Dog	Lower unit	Hyd.	Yes	53	Opt. power steering
	228 TR	V8	228	@	3800	305	1058	2:1	Yes	20	Lower unit	Mult. disk	On engine	Hyd.	Yes	53	Opt. power steering
	330 TRS/TR	V8	330	@	4200	454	1291	1.50:1/2:1	Yes	16/20	Lower unit	Mult. disk	On engine	Hyd.	Yes	53	Power steering st.
OMC	120	4	120	@	4400	153	540	1.64:1	No	14	Upper & lower units	Dog	Lower unit	Elec.	Yes	75	Optional preset
	140	4	140	@	4400	181	640	1.64:1	No	14	Upper & lower units	Dog	Lower unit	Elec.	Yes	75	trim available
	185	V8	185	@	4400	305	862	1.49:1	No	15½	Upper & lower units	Dog	Lower unit	Elec.	Yes	75	for all
	225	V8	225	@	4400	305	872	1.41:1	No	15½	Upper & lower units	Dog	Lower unit	Elec.	Yes	75	models
	240	V8	240	@	4400	351	925	1.41:1	No	15½	Upper & lower units	Dog	Lower unit	Hyd.	Yes	75	
Volvo Penta	AQ 120	4	120	@	4700	130	525	2.15:1	Yes	16	Lower unit	Cone	Vert. shaft	Elec.	Opt.	60	
	AQ 140	4	140	@	5000	130	540	2.15:1	Yes	16	Lower unit	Cone	Vert. shaft	Elec.	Opt.	60	
	AQ 200	V8	200	@	4000	305	890	1.61:1	Yes	16	Lower unit	Cone	Vert. shaft	Elec.	Opt.	60	
	AQ 225	V8	225	@	4000	305	890	1.61:1	Yes	16	Lower unit	Cone	Vert. shaft	Elec.	Opt.	60	
	AQ 255	V8	255	@	4000	350	890	1.61:1	Yes	16	Lower unit	Cone	Vert. shaft	Elec.	Opt.	60	
	AQ 280	V8	280	@	4000	350	890	1.61:1	Yes	16	Lower unit	Cone	Vert. shaft	Elec.	Opt.	60	

1978 STERN-DRIVES—DIESEL

Chrysler	MN 633	OHV 6	105	@	4000	198	n.a.	2:1	Yes	16	Upper unit	Cone	Input shaft	Hyd.	Yes	52	
	CM 655 NA	OHV 6	130	@	3150	331	n.a.	1.5, 1.75:1	Yes	16	Upper unit	Cone	Input shaft	Hyd.	Yes	52	
Renault	RC 90 DS	4	90	@	3000	219	1100	1:1 to 2.5:1	Yes	19	Upper unit	Cone or hyd.	Upper unit	Elec.	Opt.	55	
	RC 130 DTS	4	130	@	3000	219	1100	1:1 to 2.5:1	Yes	19	Upper unit	Cone or hyd.	Upper unit	Elec.	Opt.	55	Turbocharged
	RC 140 D	6	140	@	2800	363	1300	1:1 to 2.5:1	Yes	19	Upper unit	Cone or hyd.	Upper unit	Elec.	Opt.	55	
	RC 210 DTS	6	210	@	3000	343	1300	1:1 to 2.5:1	Yes	19	Upper unit	Cone or hyd.	Upper unit	Elec.	Opt.	55	Turbocharged
Stewart & Stevenson	3-53 MN	3	115	@	3000	318*	1000	1.32:1	Yes	17	Upper & lower units	Jaw type	Lower unit	Elec.	Yes	55	
	3-53 MTI	3	150	@	3000	318*	1237	1.32:1	Yes	17	Upper & lower units	Warner	On engine	Elec.	Yes	55	Turbocharged
	4-53 MN	4	155	@	3000	424*	1377	1.32:1	Yes	17	Upper & lower units	Jaw type	Lower unit	Elec.	Yes	55	
	4-53 MTI	4	200	@	3000	424*	1514	1.32:1	Yes	17	Upper & lower units	Warner	On engine	Elec.	Yes	55	Turbocharged
	6V-53 MN	6	220	@	3000	636*	1720	1.32:1	Yes	17	Upper & lower units	Warner	On engine	Elec.	Yes	55	
Volvo Penta	AQ D40 A/280	6	130	@	3600	220	1025	1.61:1	Yes	16	Lower unit	Cone	Vert. shaft	Elec.	Opt.	60	Turbocharged

*Effective displacement as compared to four-stroke diesels; these are two-stroke engines. Actual displacement is approximately one half.

The horsepower of OMC's in-line fours remains unchanged, but the V8's have increased power. The 175 is now 185 hp, the 190 ballooned to 225, and the 235 has grown to 240. All of the OMC stern-drives for 1978 retain the same 90-degree Tru-Course steering system available last year, plus the 75-degree Hi-Tilt feature, too.

Volvo Penta

Volvo has reduced the number of gasoline stern-drives in its line from eight to six for 1978. A new production division, recently opened in Chesapeake, Va., to adapt U.S.-built V8 blocks for marine use with Volvo outdrives, has made several engine changes.

A new 120-hp, four-cylinder in-line, coupled with the Volvo 270 outdrive, replaces the 108-hp four as the smallest engine in the line, while a new 280-hp V8 replaces last year's 251-hp top-of-line model. The new engine develops its power from a 350-c.i.d. block, and uses the new Volvo 280 outdrive.

Power trim is an option available for all Volvo stern-drives using the new 280 outdrive unit, which means the entire Volvo I/O line with the exception of the 120. One of the good features of this new outdrive's optional power-trim unit is a kickup system that is independent of the unit's hydraulics. This includes a quick-release feature that enables the outdrive to kick up over debris in the water without having to overcome the restraining force of the system's hydraulics. Once over the obstruction, the outdrive settles automatically back into the drive position.

Volvo's proven nine-step tough exterior outdrive finish will be back again this year. Another interesting feature retained in the line is Volvo's Everlasting Thread system: All of the bolts and fasteners used in the assembly of the outdrive are held in place with stainless-steel thread inserts (helicoils), instead of being simply tapped and threaded directly into the aluminum. Thus, it's very unlikely that the bolt's threads will easily become corroded and frozen in place by salt-water exposure.

Diesel stern-drives

There's a lot of interest in the fuel-stretching qualities of these I/O's, but relatively few are sold. Four of the most popular are offered by Chrysler, Renault, Stewart and Stevenson, and Volvo. Here's what's available for '78:

Chrysler

Chrysler offers two stern-drive diesels this year. Both are compact six-cylinder, overhead-cam, four-cycle engines, designed to be used with the same "300" outdrive as its gasoline engines.

According to Bill Maxwell, "the new 105-hp diesel is designed to save up to 40 percent more fuel than comparable gasoline-powered engines. It is practical for boats as small as 17 feet."

The 105 is fully fresh-water cooled, has a 21:1 compression ratio and a Bosch-type fuel injection system, and develops 105 hp from 198 c.i.d. at 4000 rpm. Each cylinder has its own fuel pump and a replaceable dry liner.

The 130-hp diesel develops its rated power from 331 c.i.d. at 3150 rpm, and offers the same features as the 105. The 130-horse weighs 1116 pounds.

Renault

A relative newcomer to the diesel stern-drive market, Renault offers four engines that are surprisingly light in weight at the higher horsepower ratings, although their lower-hp engines seem to be just as heavy as anyone else's. Top of the Renault line is a 210-hp four-cycle six-cylinder with 343-c.i.d. displacement. Other diesels are also available down to 90 hp. All are fresh-water cooled, and both the 130- and 210-hp models are turbocharged. Optional power trim is available for the entire line.

[Continued on page 189]

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Slow breeder makes its own nuclear fuel

Converting nuclear power plants to operate on thorium could provide a huge new reserve of energy

By JAMES G. BUSSE

Controversy over nuclear power production has slowed its development in recent years. President Carter has ordered a slowdown in the development of fast breeder reactors in this country. But several alternatives to conventional nuclear plants and fast breeders are now gaining attention. One of them, the light-water breeder reactor (LWBR), is described in this article. Other options include the high-temperature gas-cooled reactor [PS, Feb. '75] and the gas-fueled reactor.—The Editors

SHIPPINGPORT, PA.

As the room lights dimmed, dozens of reporters at the power station's visitor reception center stared at a TV monitor. Background sounds piped into the center near Pittsburgh from the White House in Washington could be clearly heard from a loudspeaker. President Carter, Secretary of Energy Schlesinger, and Admiral Rickover took their places in the Oval Office.

Suddenly, we heard what sounded like chalk squeaking across slate as President Carter began writing on an electronic "blackboard." His message on the screen: "Increase Light Water Breeder Reactor power to 100 percent. Jimmy Carter."

The superintendent of the Shippingport Atomic Power Station acknowledged the request, and on the

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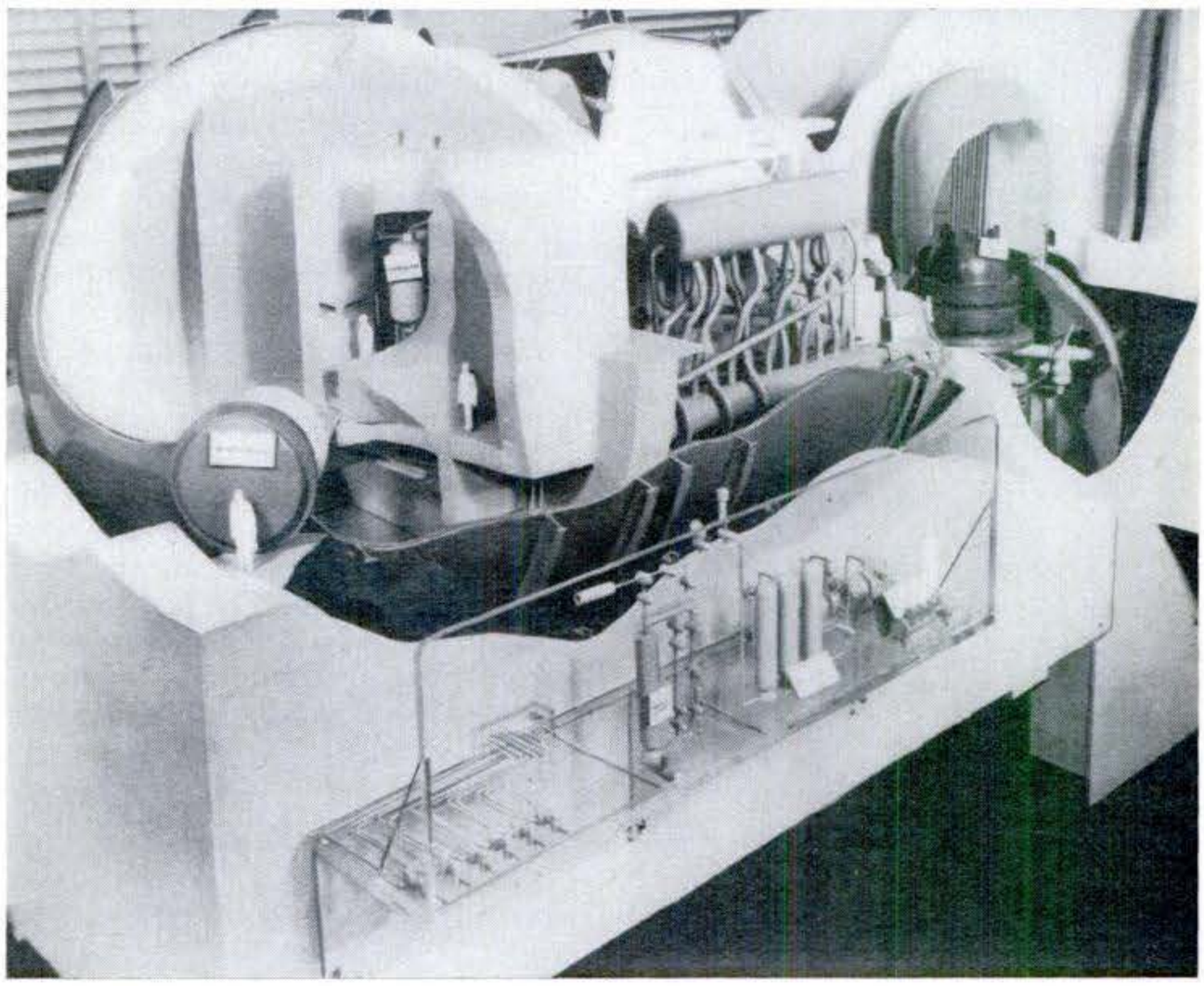

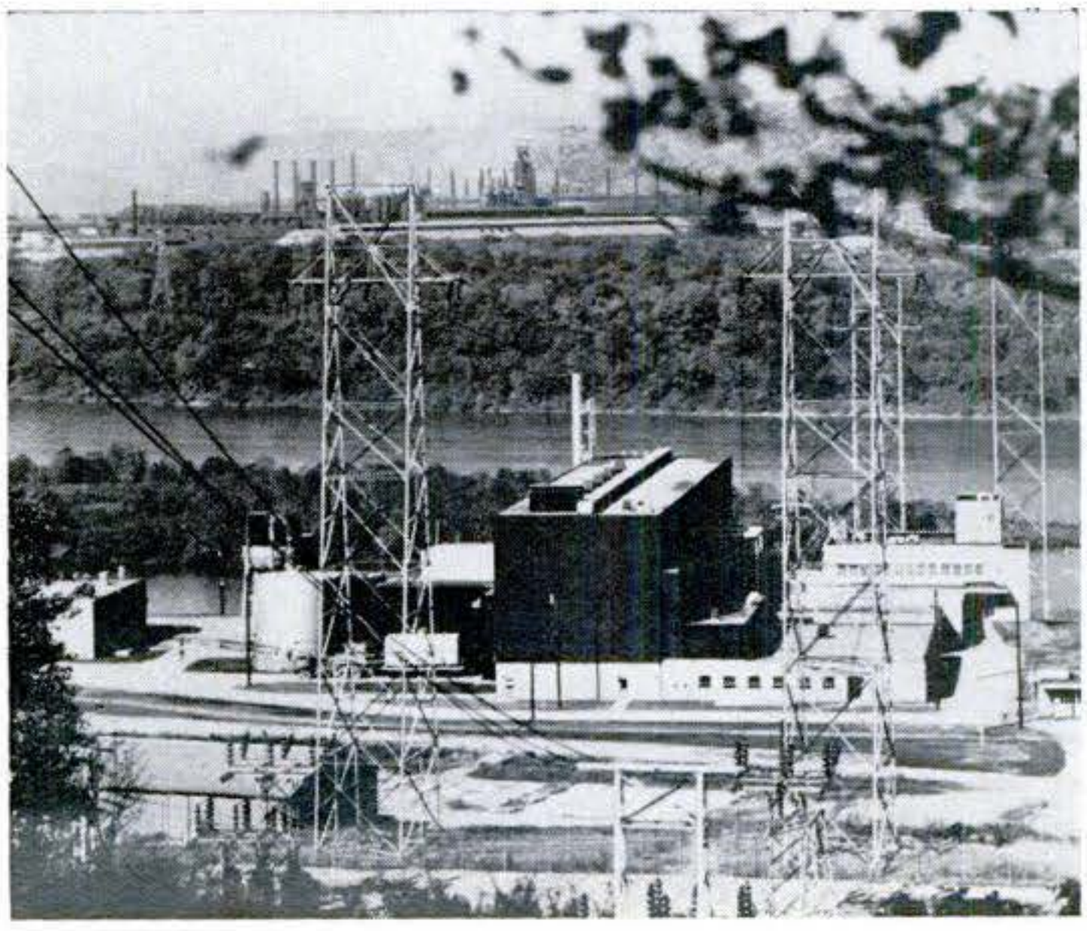

Reactor chamber (above, left) and one boiler chamber are shown in cutaway model of Shippingport's nuclear power station. The conventional light-water reactor was converted to a breeder reactor last year and will be tested for several years. Duquesne Light Co. is also building a 1000-megawatt reactor for the Pittsburgh area that dwarfs the old 60-mW unit (left).

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screen we watched meters slowly climb to the station's 60-megawatt power capacity. The age of the light-water breeder reactor, a major step toward conserving our dwindling nuclear-energy resources, had officially begun.

Conserving uranium

President Carter expressed the nuclear-fuel problem most concisely: "I understand that with light-water reactors we have enough energy to last 30 or 40 years," he said. "But if this light-water-breeder principle works, it could magnify that energy supply to maybe 600 years."

Although there is an abundance of uranium in the world, less than one percent of it is the naturally fissionable U-235 used for fuel in a nuclear plant. The remainder is another uranium isotope, nonfissionable U-238.

A conventional light-water reactor is fueled by uranium pellets in which the proportion of U-235 is substantially richer than that found in nature. It is primarily the U-235 that is involved in subsequent reactions. With reactors operating this way, uranium reserves would be rapidly depleted.

Breeder reactors are designed to solve the problem of dwindling fissionable resources. In the case of the light-water slow breeder, small pellets of fissionable uranium are used to start the reaction. These pellets are surrounded by a blanket of thorium, a cheap and abundant, though stable, element. But thorium has a highly useful property. It absorbs free neutrons from the nuclear reaction and converts into fissionable U-233. Thus, with occasional fresh charges of thorium, a reactor of this type would continue to make its own fuel forever. If used on a large scale, slow breeders could stretch our limited uranium supplies to last many hundreds of years.

It is important to distinguish between the *slow* breeder, such as the one that recently began operation at Shippingport, and the *fast* breeder [PS, Aug. '73]. The fast-breeder development program is the one that has been cut back by the Carter administration. The fast breeder uses an entirely different breeding cycle, creating fissionable plutonium-239 from stable U-238 and a startup charge of U-235.

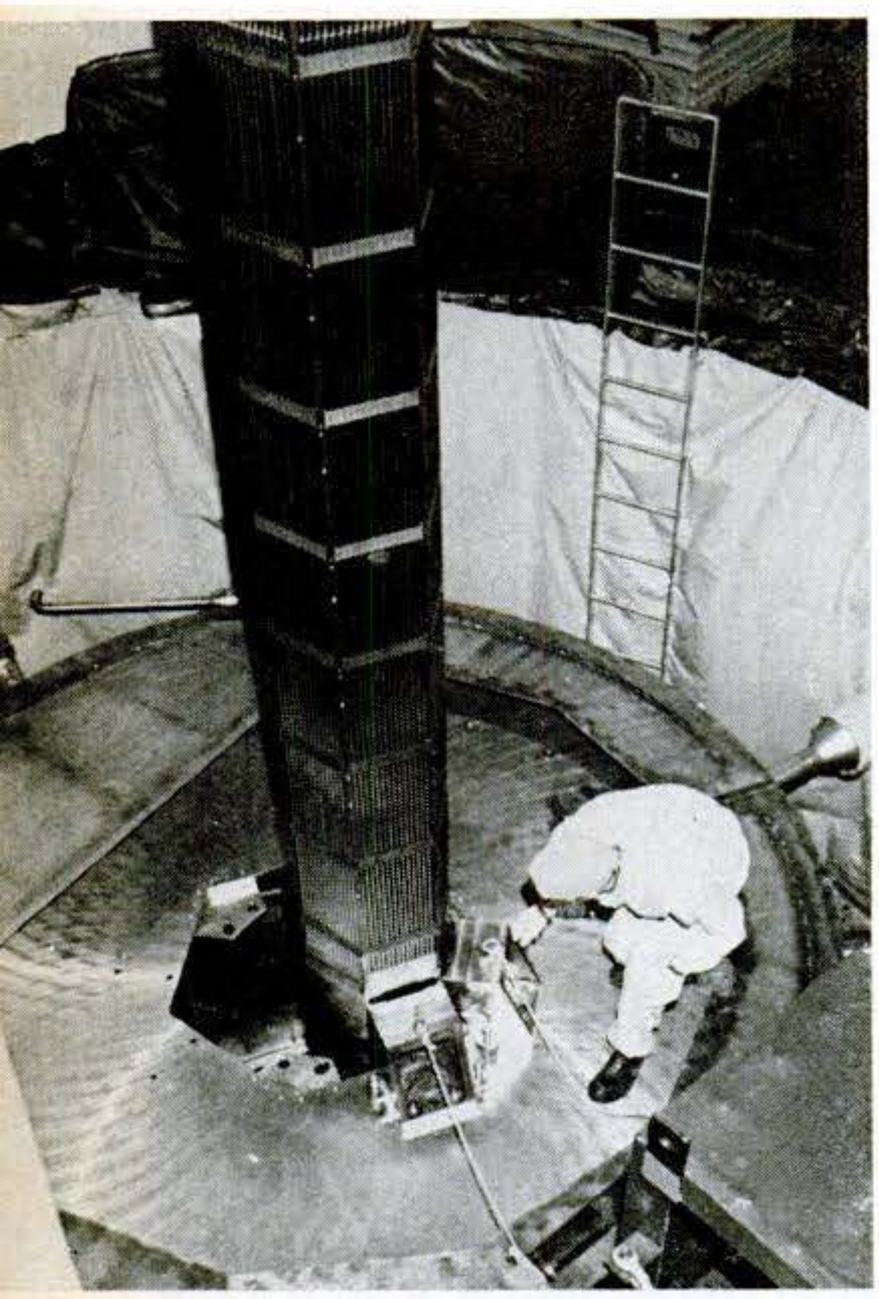
This fuel cycle has some outstanding advantages. New fuel is bred rather rapidly. After 10 years of operation, a fast breeder would actually create twice as much fuel as it used. The new plutonium could then be used to start up yet other new breeders, eliminating even the need for an initial startup charge of U-235.

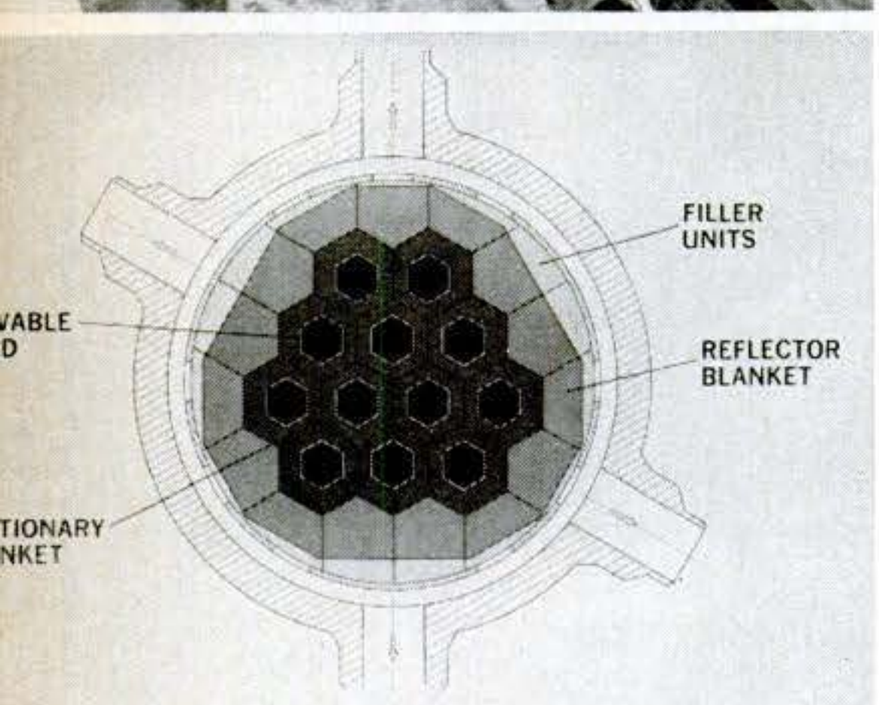
Drawbacks to development

But fast breeders also create problems. First, the U-238-to-Pu-239 fuel cycle is activated by neutrons traveling at high speed—fast neutrons. In conventional reactors, which use water to circulate through the fuel elements and remove heat, neutrons are slowed down when they strike water molecules. So, in fast breeders, liquid sodium is used as the coolant. This solves the neutron-speed problem, but raises complications of its own. Liquid sodium is highly reactive; it will explode if it even comes in contact with air or water. Thus the design of a liquid-metal fast breeder presents difficult engineering problems.

Second, the fast-breeder process produces plutonium. Plutonium is not only highly toxic, which would make it particularly dangerous should it ever be released into the atmosphere accidentally, but it's what the experts call a "bomb-grade" material. If international terrorists ever managed to hijack a sufficient quantity from a reactor, they could use it to make an atomic bomb. So could an emerging country that got a fast breeder reactor in a technology exchange program.

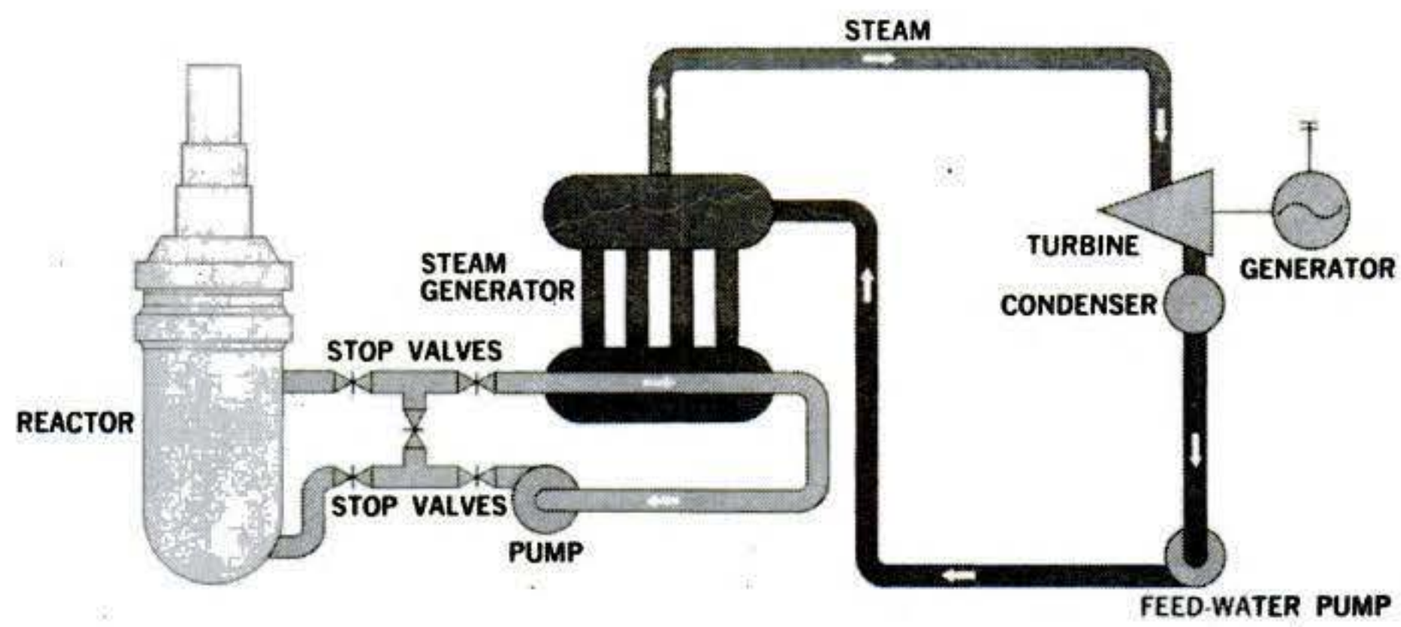
While you can argue about the probability of such events, these considerations were largely responsible for the Carter administration's





Reactor core contains narrow rods filled with fuel pellets. Seed modules containing about five percent U-233 are surrounded with a thorium blanket. The seed pellets convert the thorium into more U-233, suitable for refueling.

From thorium to electricity—a closed-cycle system



A power-generation cycle that fuels itself: High temperatures from the uranium-thorium pellets in the reactor core heat water, which enters at the bottom of the pressurized vessel and leaves near the top. Then it is pumped through four large steam generators. High-temperature steam drives a turbine-generator set. Condensed water is returned to the cycle. The small Shippingport reactor has been designed to duplicate core conditions of higher-capacity units.

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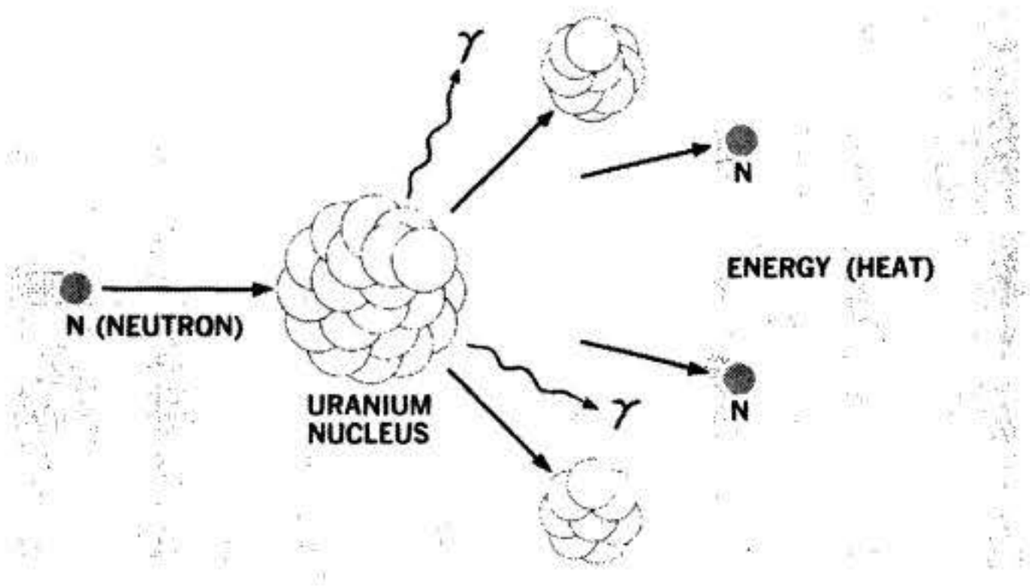
How the thorium LWBR works



PRESENT LIGHT-WATER REACTORS

U-235 → FISSIONS (→ ENERGY) → IS USED UP → REFUELED WITH MORE U-235

LIGHT-WATER BREEDER REACTOR

U-233 → FISSIONS (→ ENERGY) → PRODUCES MORE U-233 FROM THORIUM → REFUELING ONLY REQUIRES MORE THORIUM SINCE U-233 IS RECYCLED

When an atom of nuclear fuel splits, it releases several neutrons in addition to some radiation and energy in the form of heat. To sustain a nuclear chain reaction, at least one of these free neutrons must strike another atom of fuel and cause it to split. Conventional light-water reactors burn up their enriched uranium fuel during the course of the reaction, although a small amount of fissionable plutonium is produced as a by-product.

Breeder reactors carry nuclear theory one step further by maximizing production of new fissionable material. Not only must one neutron from each splitting atom activate another atom, but a second free neutron must be used to convert a stable atom, uranium-238 or thorium-232, into a fissionable one, plutonium-239 or uranium-233. Hence, in a breeder, at least two neutrons must be utilized. Splitting atoms, on average, release 2.5 free neutrons.

The light-water slow breeder differs from the liquid-metal fast breeder in the neutron-absorbing properties of their respective fuels. Thorium, used in the slow breeder, can accept an additional neutron only at low speed, while U-238 converts to plutonium with the addition of a "fast" neutron. Slow breeders use water as a moderator to deflect and slow the neutrons. The same water serves as the reactor coolant, or heat-transfer medium. Fast breeders use liquefied sodium, which doesn't affect neutron speed, to carry away the heat of the reaction.

The Shippingport LWBR is fueled by a small amount of fissionable uranium covered with a blanket of thorium-232. When an atom of uranium splits, one free neutron is used to sustain the reaction and another is slowed and absorbed by a thorium atom. This quickly decays to form a new atom of fissionable U-233. Thus, for every atom of uranium consumed, slightly more than one new one is created. The net effect is to breed more fuel—slowly.

decision to cancel construction of the most important demonstration reactor in the liquid-metal fast-breeder program.

Fortunately, the *slow* breeder does not have these same disadvantages. In addition, it has some startling advantages of its own. To begin with, it does not make plutonium. Second, it requires no complex new liquid-sodium-handling technology. In fact, current light-water reactors now operating in this country can be converted to light-water slow breeders simply by installing new cores.

Safe, plentiful fuel

Finally, the fuel for the slow breeder—thorium—is cheap and abundant. The world's known reserves of thorium are found in ores in Sri Lanka (Ceylon), Madagascar, Norway, Sweden, Canada, and the western United States. Certain sands along the rivers and ocean beaches of Brazil, India, and North and South Carolina are particularly rich in the element. South Carolina's beach sand, the chief source in the U.S., contains up to nine percent thorium oxide.

Thorium, like uranium, is naturally radioactive. But except for its limited use in the past in making vacuum tubes and gaslight mantles more efficient, thorium has remained something of a technological enigma. If we can recover only half of the energy contained in our known thorium reserves, we will gain more than seven times as much power as can be generated from the world's remaining reserves of coal, oil, and natural gas.

Various countries, including the U.S., have been quietly stockpiling thorium, waiting for scientists to find a practical way to unlock its tremendous power. But until recently some tough technical problems stood in the way of that goal. Calculations showed that in the slow-breeder reaction, there would be a relative scarcity of neutrons available to convert the thorium to U-233.

Then, in the early 1960's, further experiments and more accurate data indicated that U-233 probably produced more slow neutrons than previously believed. During the following decade, engineers made a series of important advances in reactor technology. First, they figured out a way to get the fuel rods in the reactor core closer together to reduce slow-neutron wastage.

They used a zirconium-alloy tubing to encase the fuel pellets. Zirconium absorbs fewer neutrons than stainless steel, which had been widely employed for this purpose. They also designed a unique "seed-blanket" fuel arrangement within the reactor core to release the greatest number of neutrons and to use them as efficiently as possible in the breeding process. And finally they developed designs for larger nuclear reactors offering less neutron loss through leakage. Units in the 1000-megawatt range are now considered standard.

The seed-blanket method of fuel utilization was developed at Shippingport. Basically, it involves surrounding the "seed" (a fuel module containing about five percent U-233) with a "blanket" of thorium. The U-233 produces the LWBR's thermal energy and supplies slow neutrons to the thorium, where most of the breeding occurs. The thorium blanket, ready to use or reflect any leftover neutrons, surrounds the core to minimize neutron leakage.

Shippingport startup

The revamped Shippingport plant began producing energy as a light-water breeder for the first time last August. A commercial LWBR, like a conventional light-water reactor, probably would be shut down once a year for fuel changeover and routine maintenance. About one-third of its fuel would be replaced with fresh fuel at that time. How-

[Continued on page 200]

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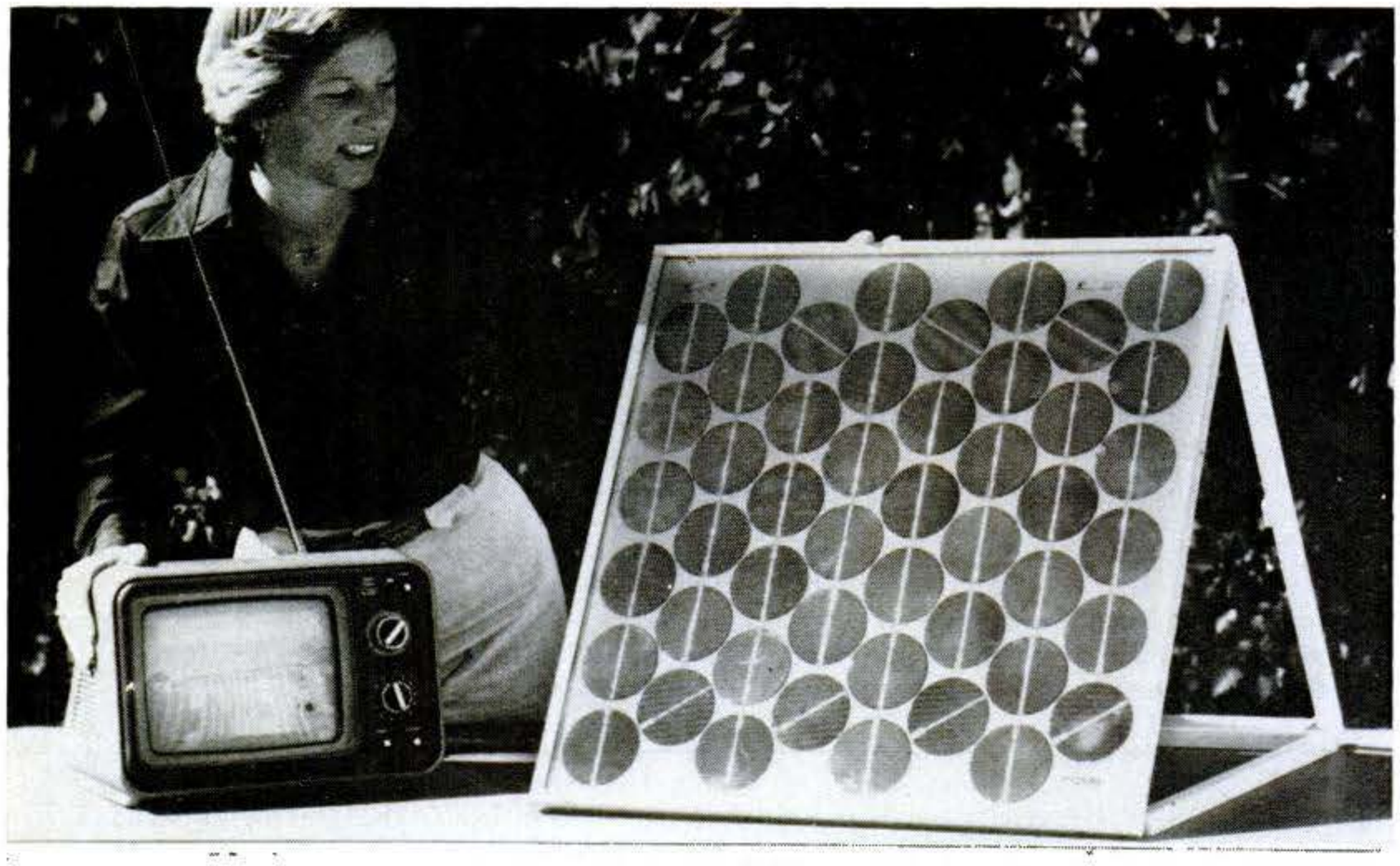
What's New

A PICTURE ROUNDUP OF NEW PRODUCTS AND DEVELOPMENTS

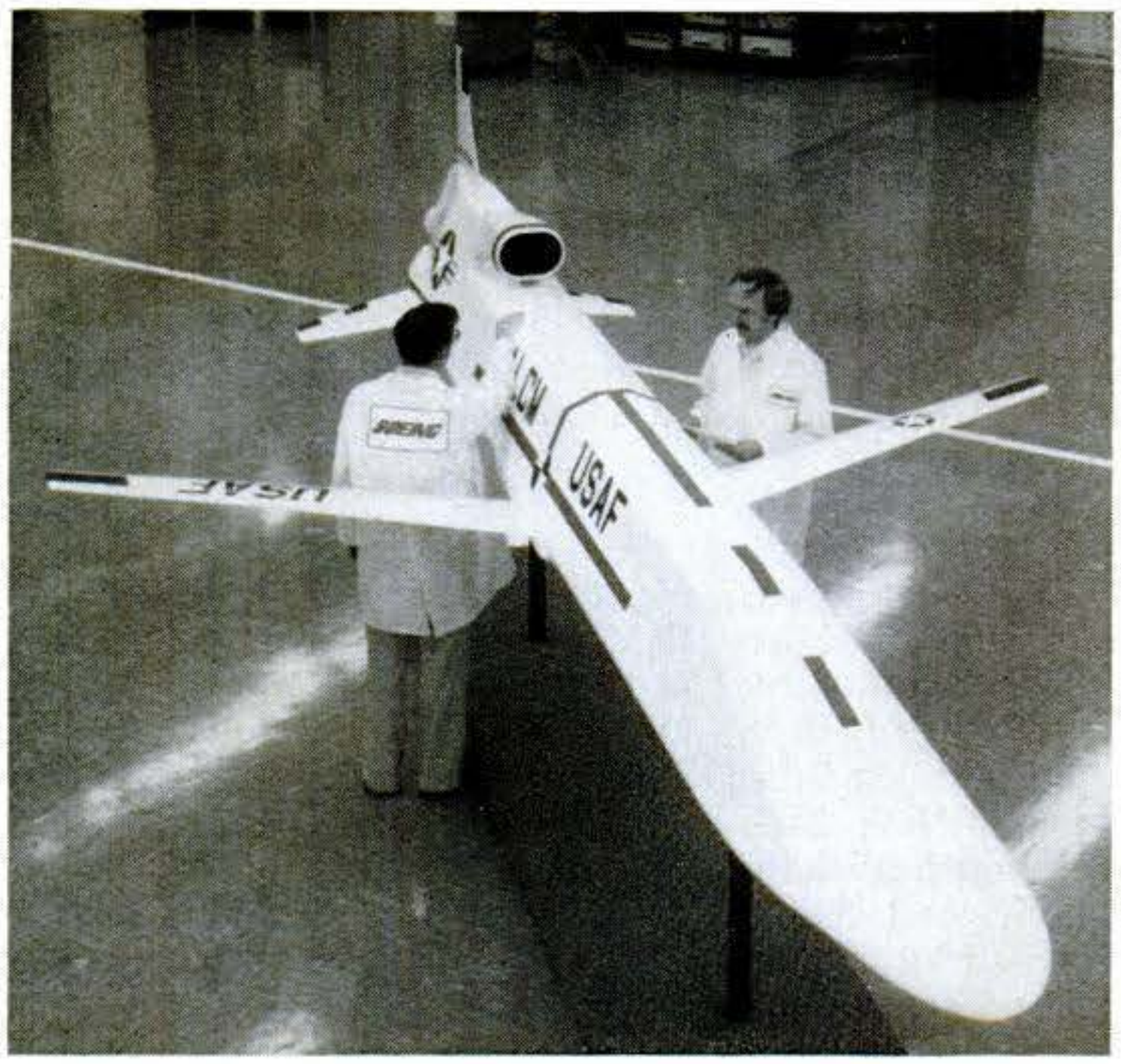


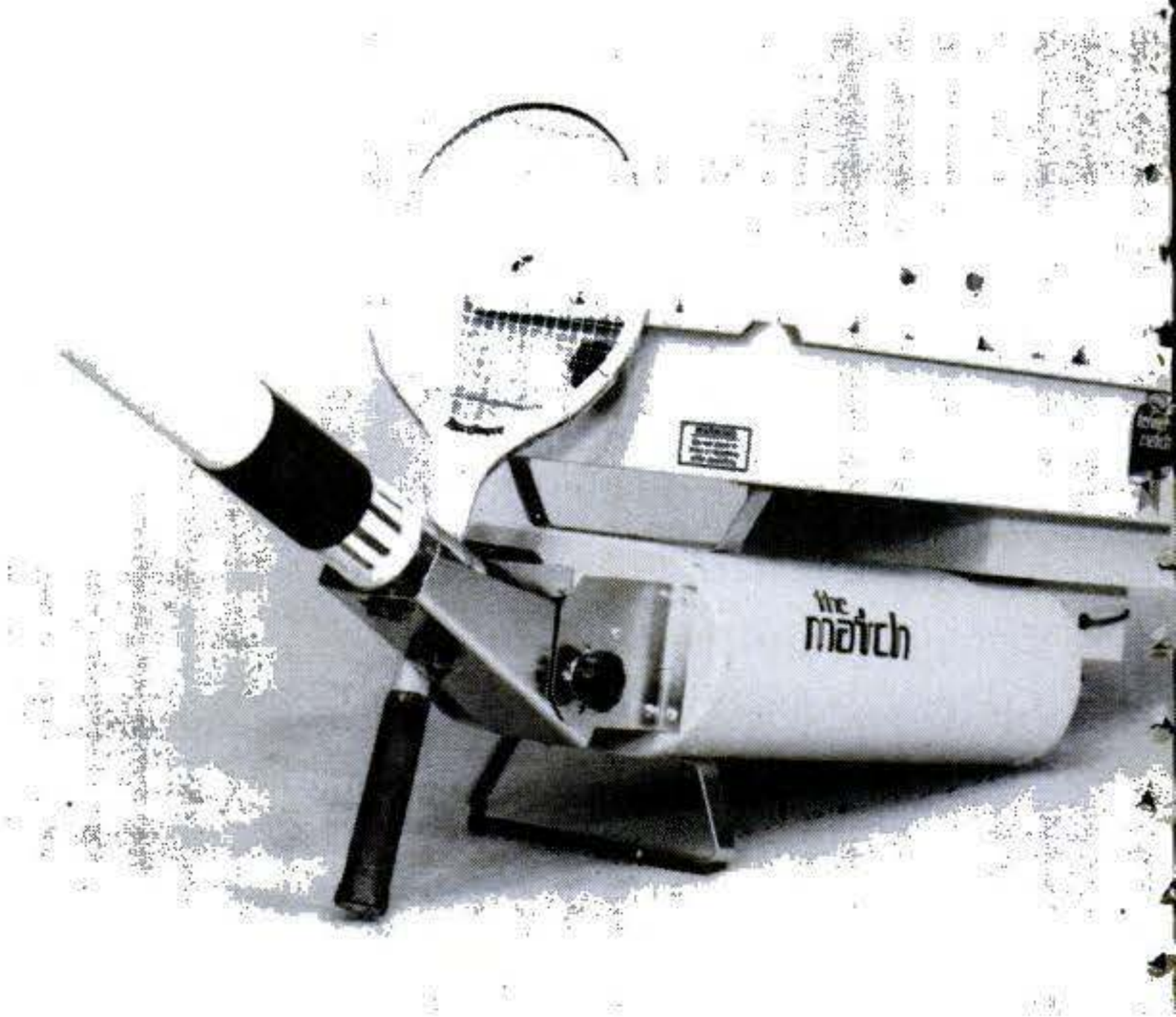
Fiber drive shaft

Supertough, lightweight auto parts made with carbon-fiber composites may give you more mpg. In Britain, Hyfil made an experimental drive shaft (right) that weighs 11.5 lbs. instead of 19.8 lbs. for steel. A fiber leaf spring weighs six lbs. instead of 28 lbs.

For TV watchers: solar power

If you're a daytime-TV fan, here's a setup that eliminates worries about power failures or weak batteries. A 12-volt portable TV set plugs directly into this 48-cell solar module. The three-inch cells convert sunlight directly into DC electricity, producing up to 25 peak watts (noon on a clear day). Cells are manufactured by implantation of phosphorus ions into p-type silicon wafers. Hermetically sealed glass sheets on the front and back protect the cells. Spire Corp. (Patriots Park, Bedford, Mass. 01730) manufactures both the solar cells and modules.





Cruise missile

Launched from B-52 rotary racks or wing pylons, the Boeing-made cruise missile locates targets by comparing radar readings with maps stored in its computers. Before launching, the missile's six-ft. wings, tail fin, and elevons fold into the 20-ft. body.

Tennis machine

Want to perfect your lobs, volleys, and service returns? Tennis Match is a 30-lb. machine that serves tennis balls at three preset intervals or when actuated by optional wireless remote control. $330. Tennis Match, Inc., 849 Jerusalem Rd., Scotch Plains, N.J. 07076.

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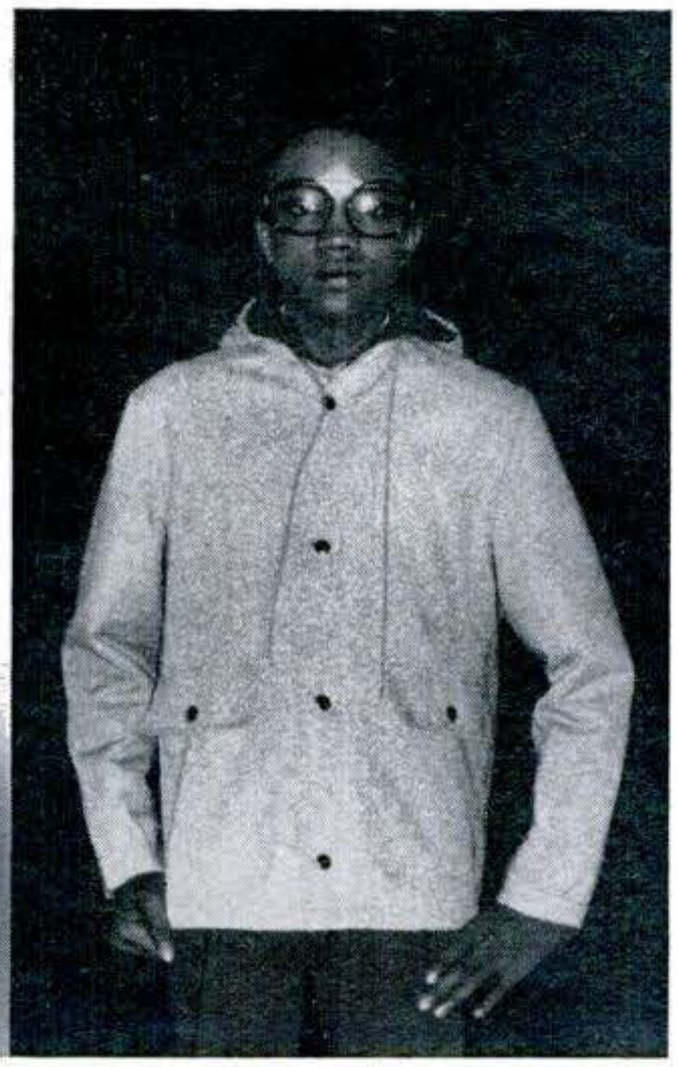


Reflective clothes

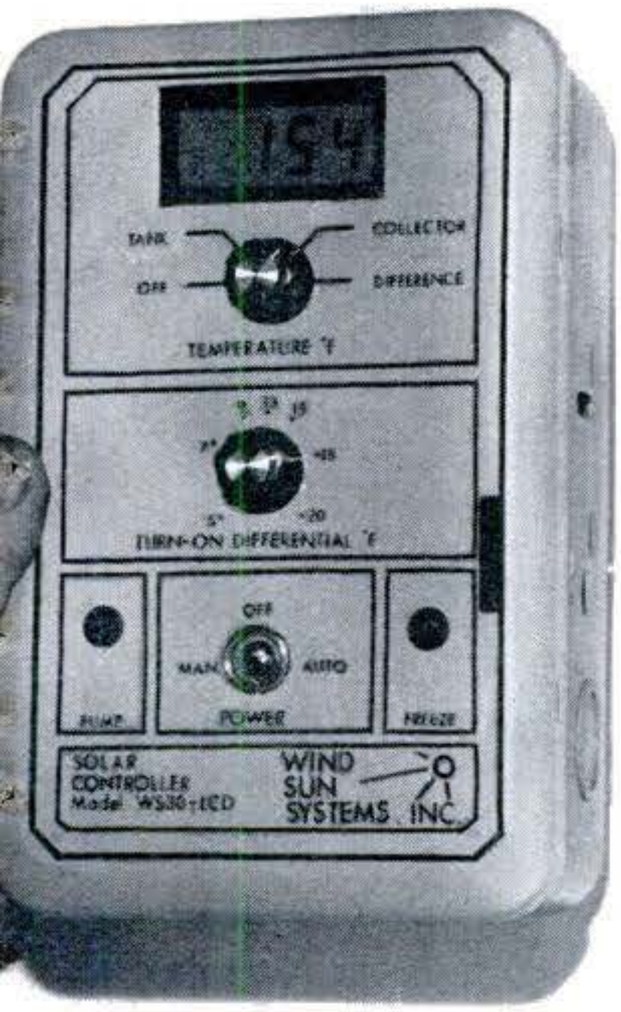
A new reflective finish that doesn't alter the color or appearance of fabrics by day makes them glow brilliantly at night under car headlights (right). The 3M finish is being used on several outerwear garments in Fashion Rite's London Fog children's line.

Tailgate sign

"Move apart," this experimental sign in Great Britain warns drivers who are tailgating. Infrared light beam measures both speed and distance to compute safe driving interval. Department of Transport hopes the signs will help prevent highway pileups.

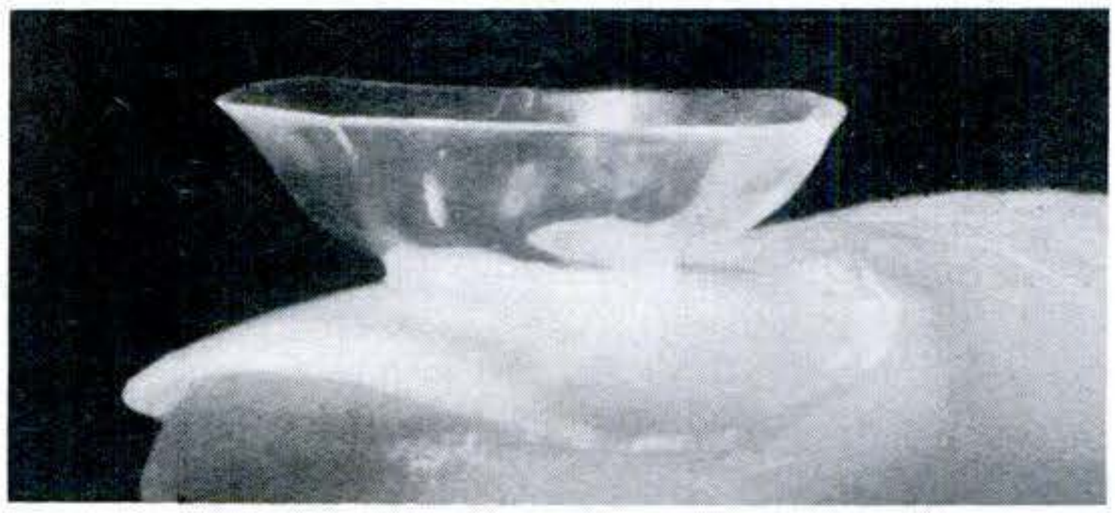
Light plane

Strap yourself into Birdman's open-air cockpit and its 11.5-hp, two-cycle engine propels you from 14 to 55 mph. The redesigned plane weighs only 122 lbs. Kits are $3245. Birdman Aircraft Inc., 480 Midway Airport, Daytona Beach, Fla. 32014.



Six-wheeler

Even James Bond would envy Panther 6 owners. The six-wheel, 600-hp British supercar goes from zero to 100 mph in under eight seconds. Four low-profile front wheels improve road grip and cornering. Panther Westwinds makes only one $70,000 car a month.

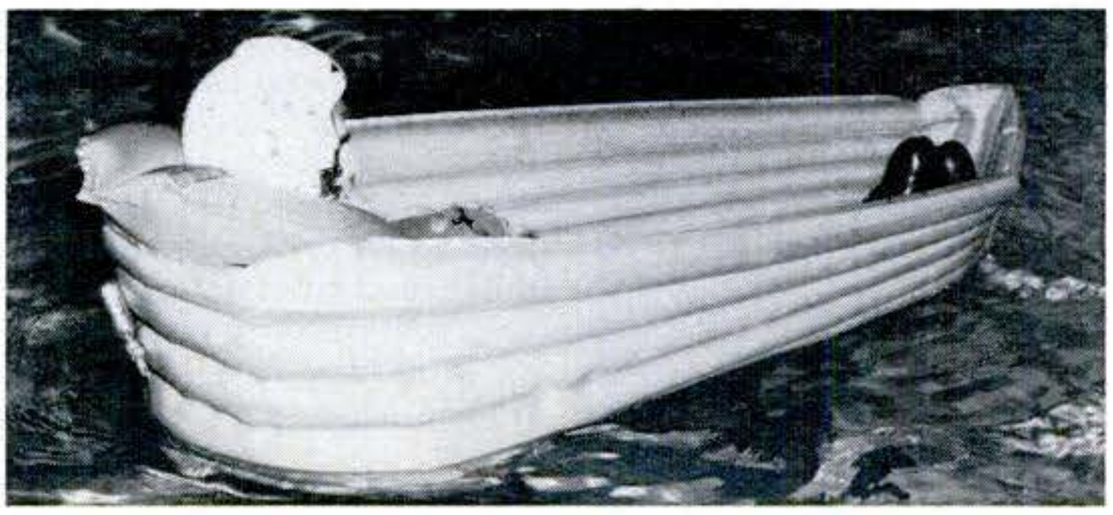


Soft bifocal contacts

This British-made soft contact lens has two separate curvatures for distance or close-up viewing. The distance portion is a central circle. To use the surrounding close-up ring, your lower eyelid holds the soft-plastic lens up while you look through the outer rim.

Solar-controller kit

Here's the first solar controller available in a kit, claims the maker. Controller measures temperatures in collectors and storage systems and circulates fluid heated by sun. Price: $30-$105, depending on options. Wind Sun Systems, Box 3300, Austin, Tex. 78764.



Mini-boats

Helicopters downed in water sink fast, so crews can't launch big rafts. The Navy has developed new single-person Mini-Boats each crew member can wear. The inflatable boat fits into an 11-by-11-by-1-in. pack—one-third the bulk and half the weight of older rafts.

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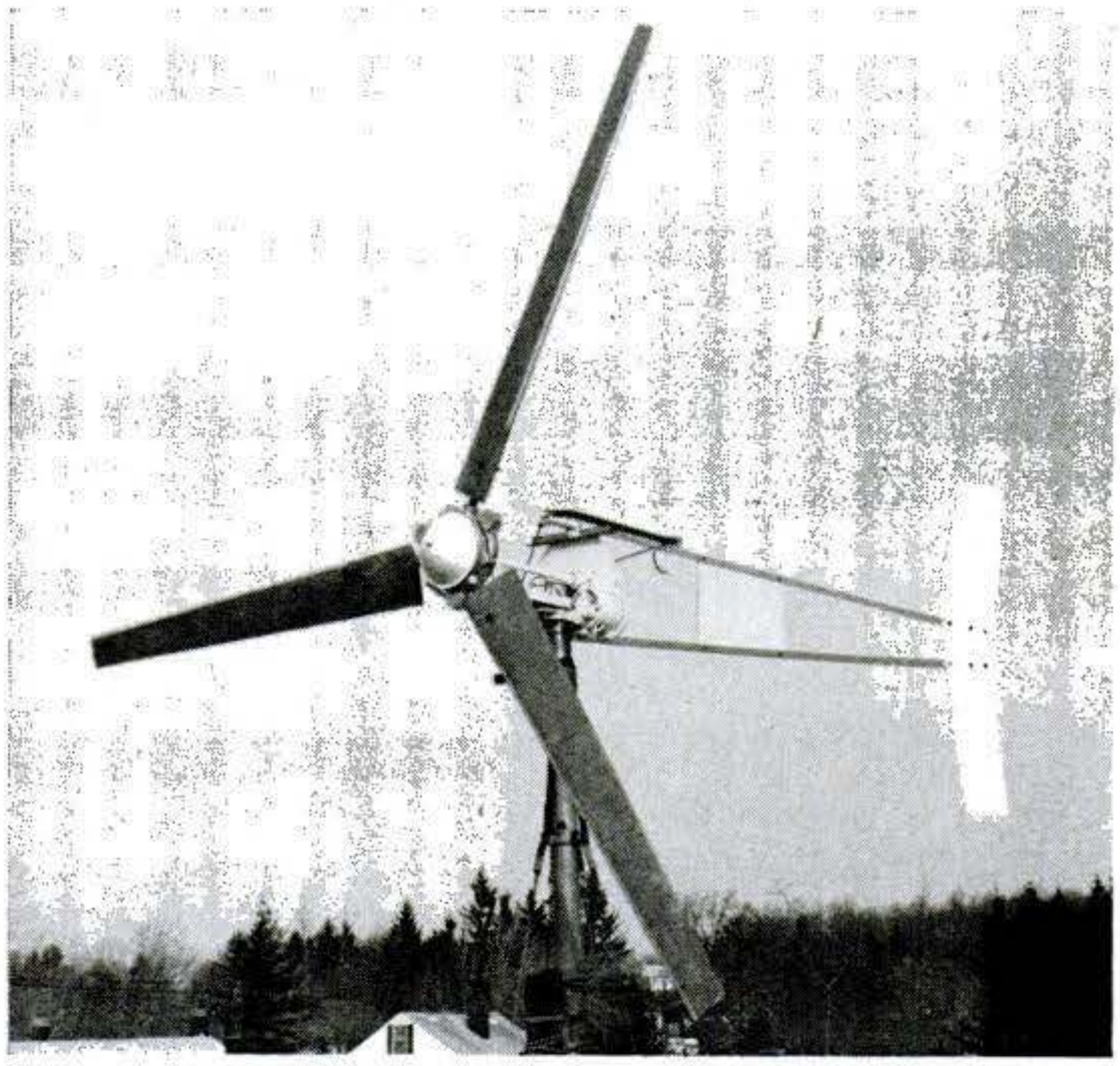
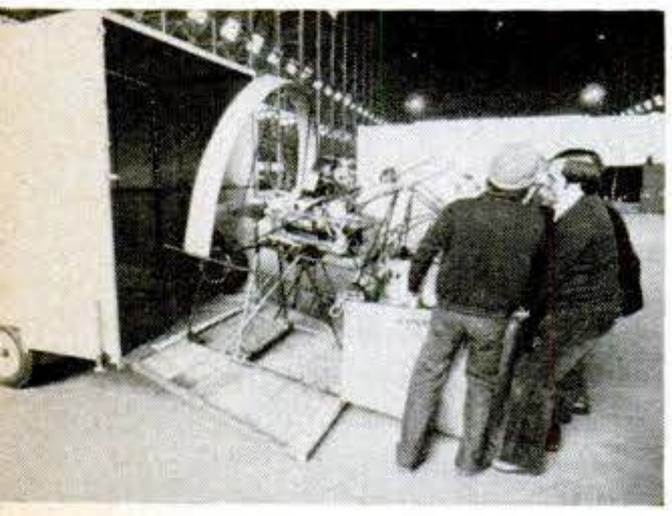
What's New

Solar switch

The sun's heat actuates a spring-operated valve to allow solar-heated water to rise and circulate in thermosiphon solar heating systems. At night the valve closes, preventing heat loss. The Solarsyphon Diode is $97. Sun of Man, Drawer W., Bethel Is., Calif. 94511.



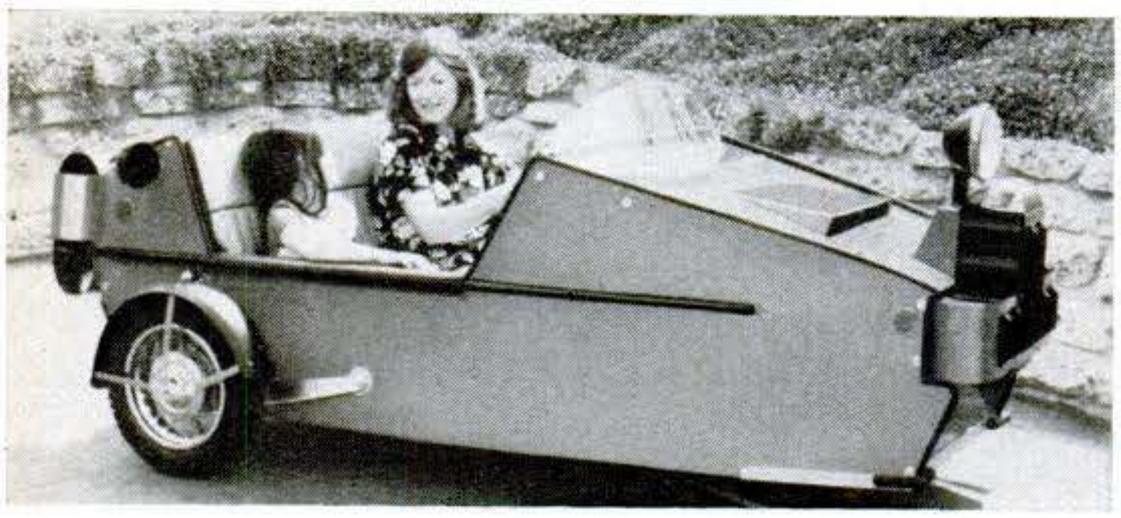


Economy airship

The first hot-air blimp is cheaper to inflate than helium-lifted ships. Liquid propane gas (LPG) heats the air that fills the 96,000-cu.-ft. envelope. LPG also fuels the converted VW engine (left) that propels the ship. Total fuel cost for a one-hour flight: $20.

Domestic generator

Hot water from a windmill? This one generates 2.5 kW—enough power to heat the coil in your hot-water tank. The 16-ft.-diameter rotor spins in 10-mph winds, reaches full capacity in 24-mph winds. Price: $2989. From Astral Wilcon, 127 W. Main St., Millbury, Mass.

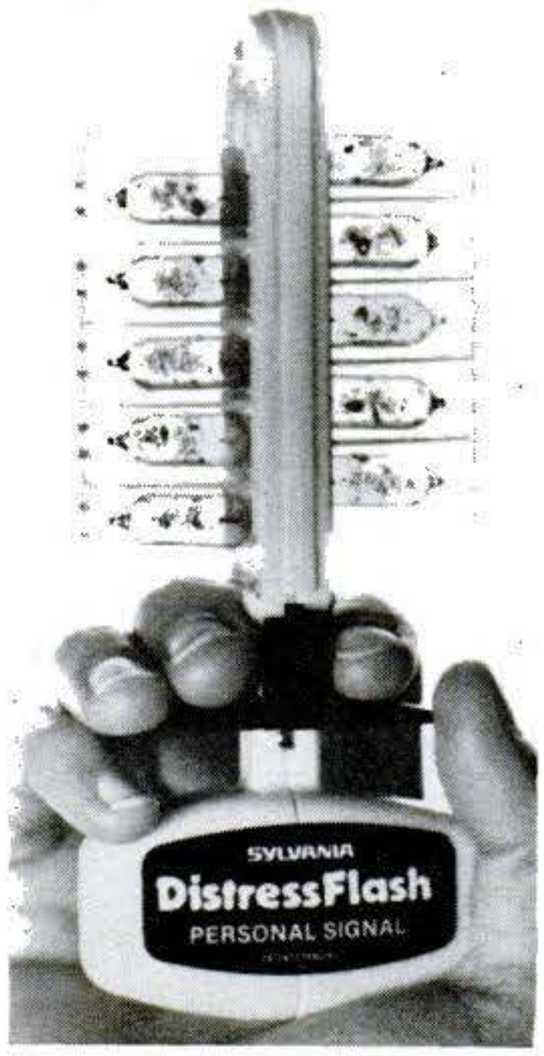


Electric-car kit

This two-passenger electric car is a runabout for city dwellers. It can hit 30 mph. A four-battery power pack gets about eight miles per kWh, and recharges on house current. The minicar will soon be available as a kit from 3E Vehicles, Box 19409, San Diego, Calif.

Cargo hauler

Lockheed's new twin-engine Hercules has more cargo capacity than others in its class. The plane can fly 22,500 lbs. of cargo for 550 miles, and can land on dirt or gravel runways as short as 3600 feet. Two 4910-hp Allison engines supply power.



Signal flasher

Stranded on a lonely road? Squeeze the Distress Flash trigger and an ordinary flashbulb goes off with a brilliance that can be seen three miles away, says Sylvania. The disposable, 10-bulb unit needs no batteries and is both waterproof and buoyant. $5.

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What's New IN BOATING

BY SUSAN RENNER-SMITH

Care-free battery

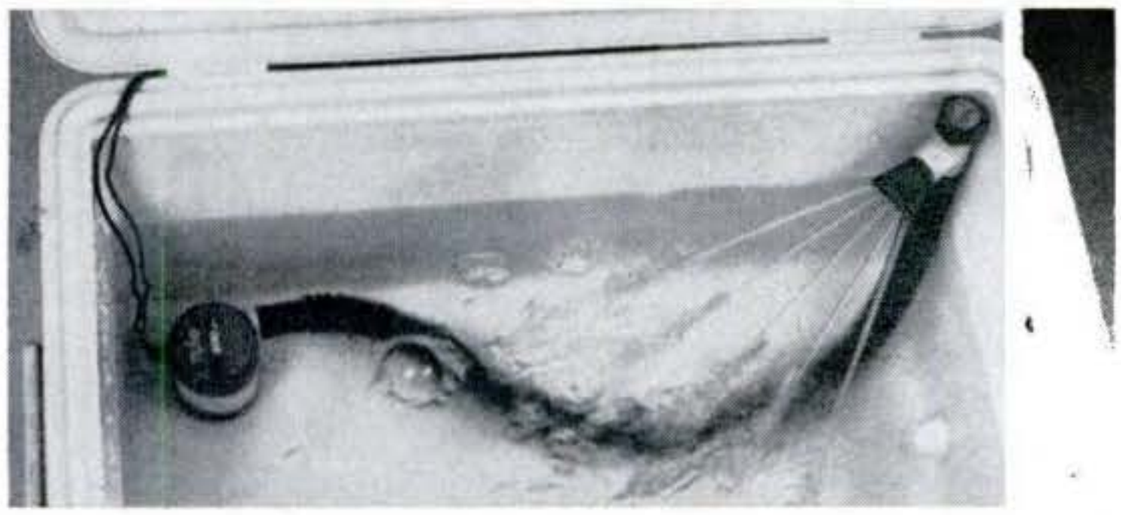
The first no-fill marine starting battery is the Gould Stowaway. It can produce 550 "cold-cranking amps" for starts at 0° F. The maintenance-free battery is also highly corrosion-resistant and should last twice as long as a conventional battery, says Gould. Price: $59.95.

Basic fisherman

Stable and roomy, MFG's new trihull Super Challenger 14 is 14 ft. 3 in. long with a 62-in. beam. Overhanging gunwales on the fiberglass craft make for a drier floor, according to MFG. The boat costs $730 and is rated for a 20-hp, short-shaft outboard.

Simple autopilot

Like a third hand, the Tillerman rudder lock holds the tiller while you adjust the rigging. Light finger pressure is all you need to lock or release the line, says maker (United Yachting Mfg., 23230 Tireman Ave., Dearborn Hts., Mich. 48127). The line is easily removable. $20.

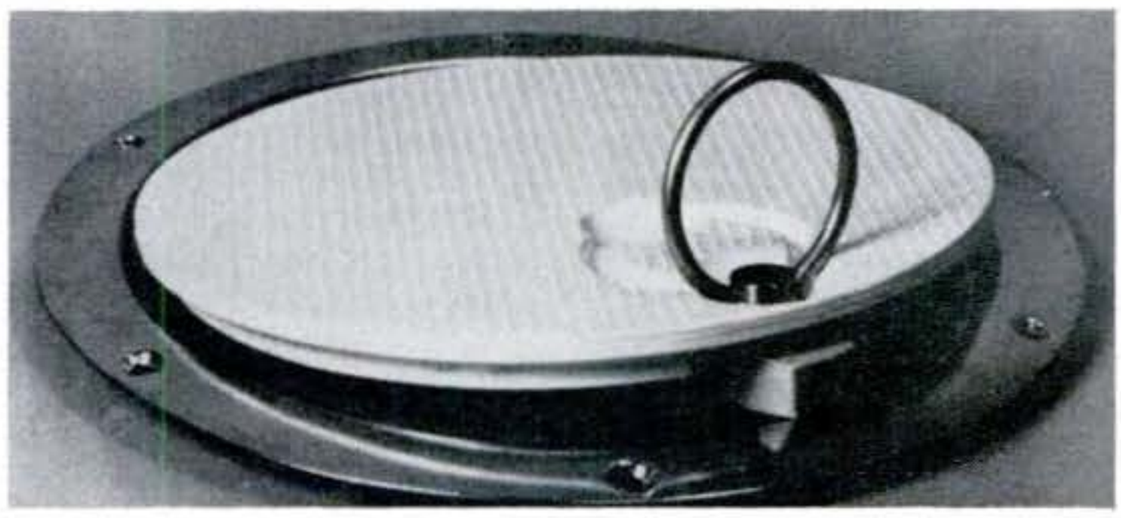


Portable live well

You can keep your bait or catch alive with Livewell Oxygenator System. Components—a 400-gph, 12-VDC pump, oxygenator valve with five-jet spray head, and four-ft. hose—install in any fish tank. Rule Industries, Cape Ann Ind. Pk., Gloucester, Mass. 01930. $31.95.

Survival jacket

For double protection in icy waters, the Offshore Survival Jacket has an inner stretch lining that acts like a wetsuit. The outer jacket, lined with closed-cell foam, gives both flotation and extra insulation. Price: $222. Stearns Co., Box 1498, St. Cloud, Minn. 56301.



Deck port

Want to check below decks without wrestling with the hatch? This little inspection port makes it easy. The eight-inch-diameter sturdy plastic door locks into a stainless steel, deck-mounted ring. Viking Mfg. Co., 1630 W. Cowles St., Long Beach, Calif. 90813. Price: $37.68.

Small-craft kits

You can build these small craft in your own yard. Made from western red cedar, each boat is completely fiberglassed. Materials, directions, and full-size patterns cost $300-$350 from Manitou Industries, 111-14151 Westminster Hwy., Richmond, B.C., Canada.

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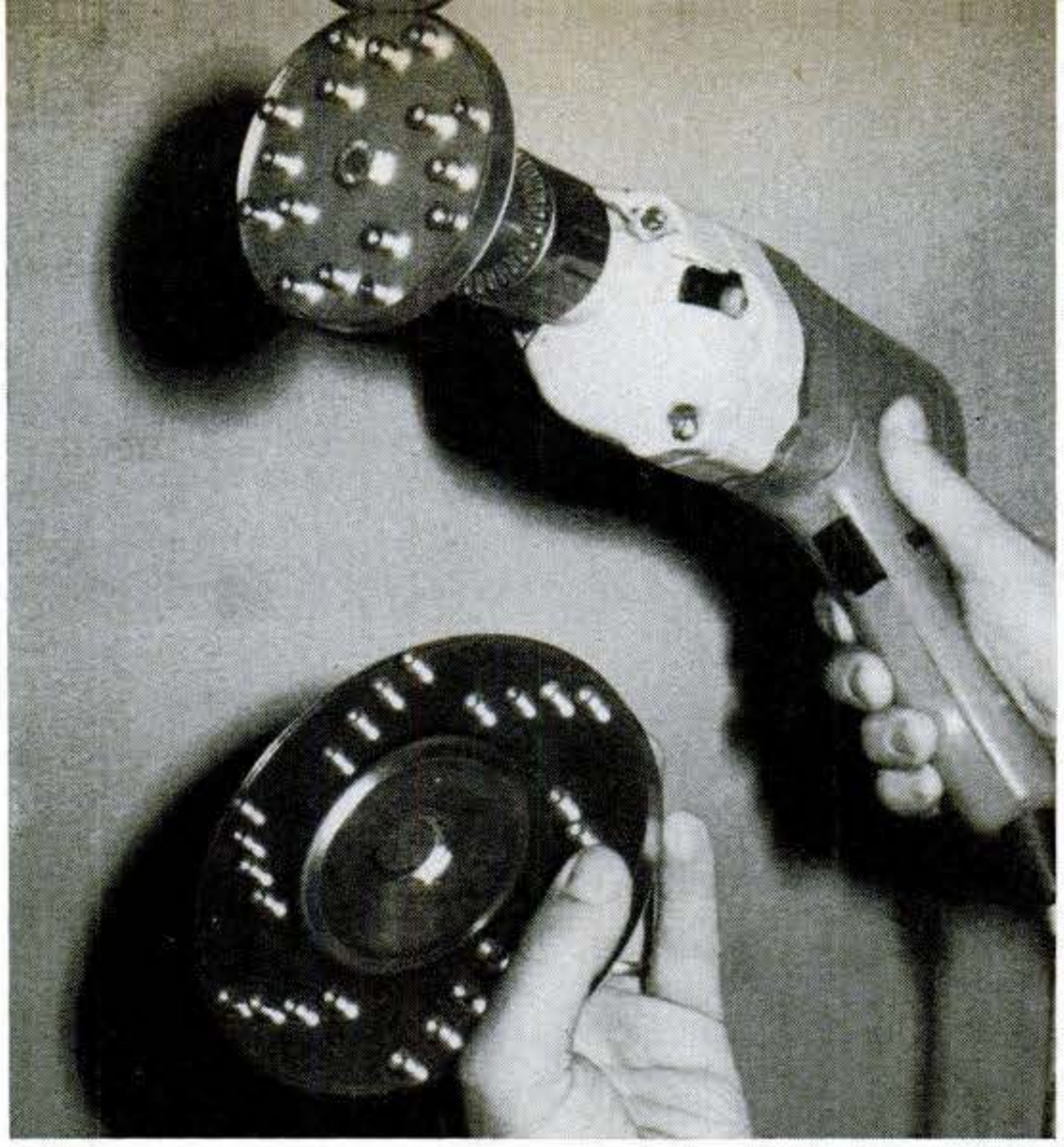
What's New IN TOOLS

BY R. L. STEPLER



Tiller

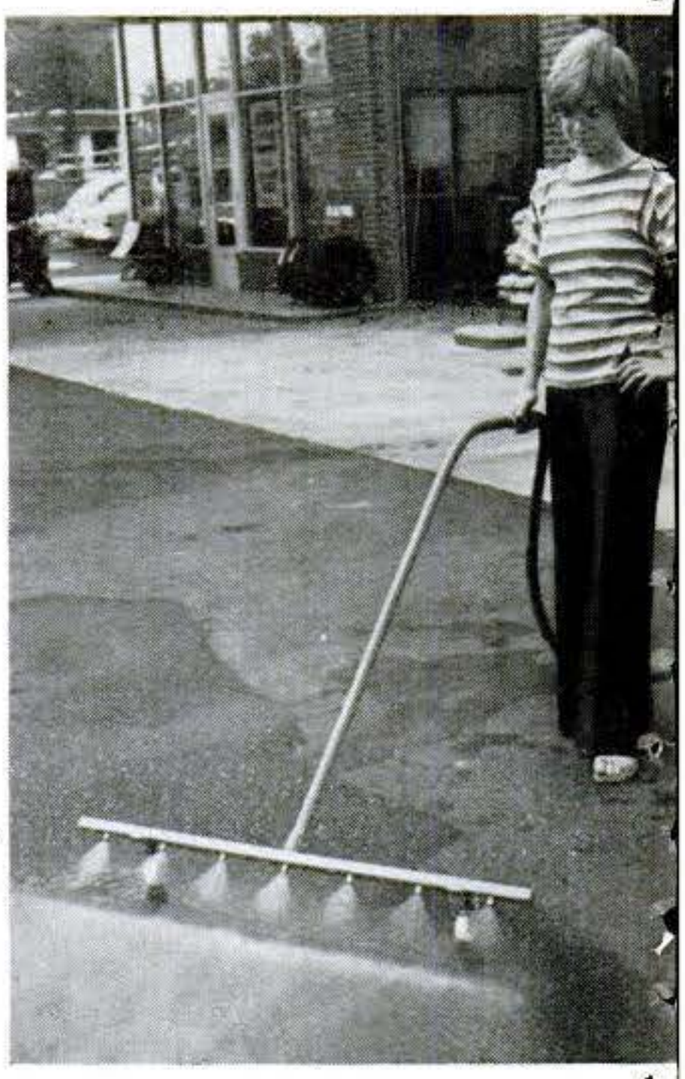
No pushing or pulling with this electric tiller, says Black & Decker: You simply guide it. With cultivating tines, the model 8350 costs $130. Accessories include a lawn thatcher ($30) and digging tines ($10). Black & Decker, Towson, Md. 21204.

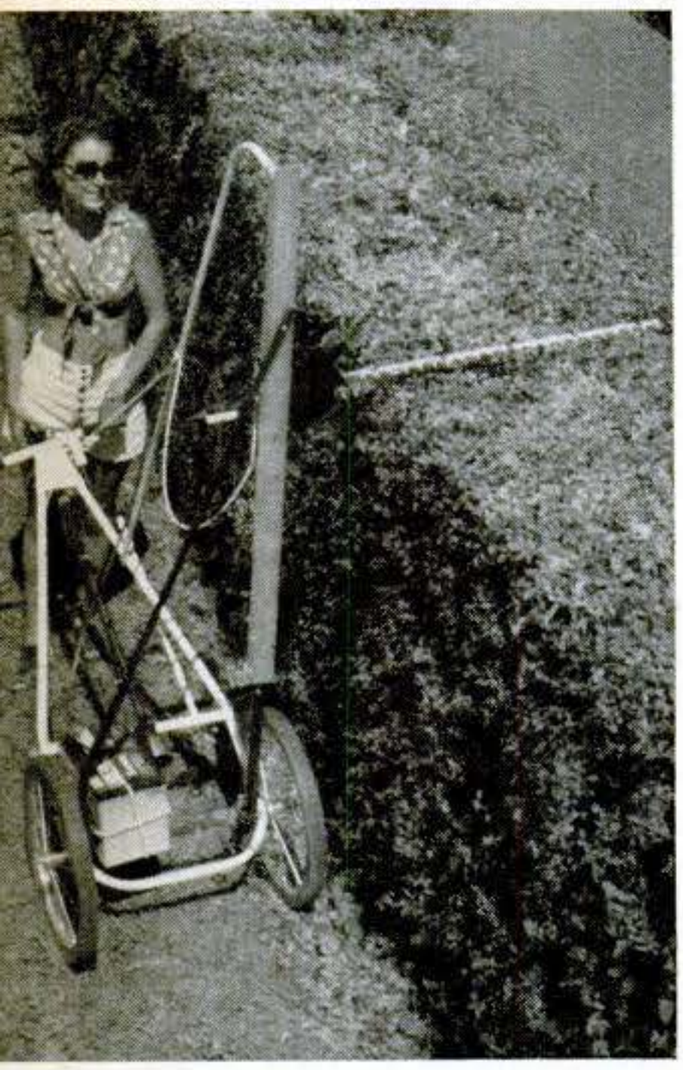
Tool belt

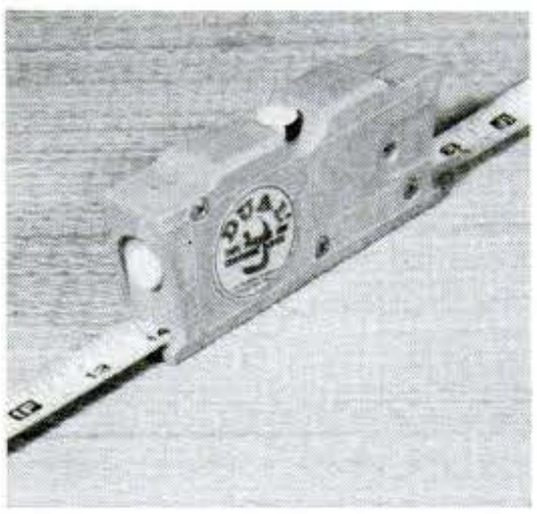
A helpmate for the well-equipped handyman is this new tool belt with 10 pockets for nails, screws, screwdrivers, pliers, hammer. The Action belt is $18.95 at hardware stores. Action Leathercraft, 5340 E. Harbor St., Commerce, Calif. 90040, makes it.

Abrasive disk

Rotorasp's tungsten-carbide studs strip paint, de-bark timber, remove rust, or smooth concrete blocks, claims the Norwegian maker. An electric drill powers the 3"- and 5"-dia. steel disks. Sold here by Schou-Gallis Ltd., 101 Mission St., San Francisco, Calif. 94105.

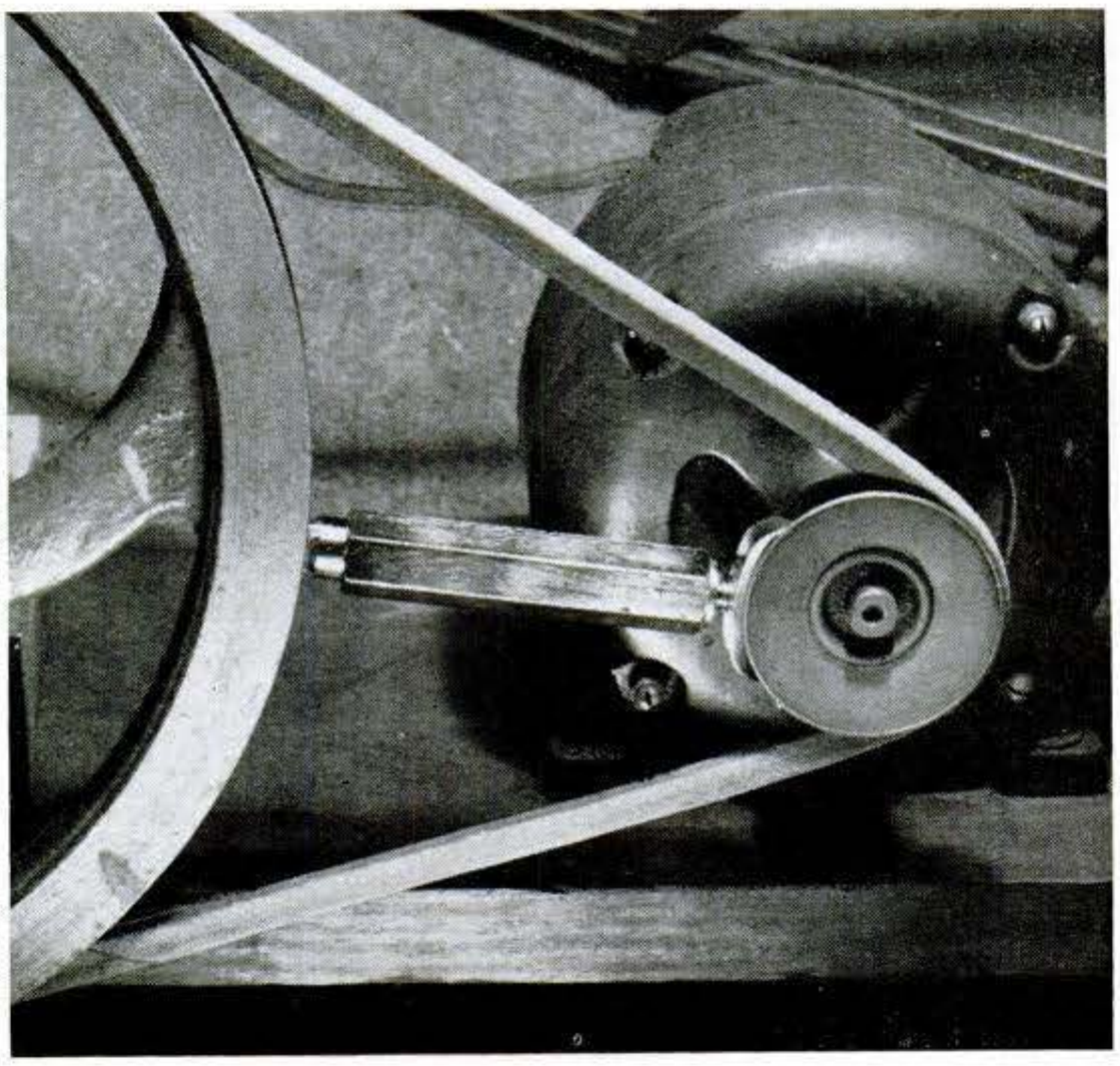






Two-way tape

Finding a centerline is easy with Dual-2, says the maker; there's even a built-in scribe to mark it. Two 12' tapes in the 5"-long plastic case give the device a 24'5" measuring capacity. It's $19.95 from Dual-2 Tape Measure Co., Box 16296, San Francisco, Calif. 94116.



Water broom

Sweep debris from the drive with the Jetaway water broom. Seven nozzles spray a 42"-wide swath. The device uses city water pressure, ordinary garden hose. It's $80. Maker: Southeastern Machine & Tool Co., Box 31087, Raleigh, N.C. 27612.

Tall trimmer

Trimming hedges up to nine feet high is easy with Quick Cut, says the maker. Auto battery powers the 30" shears; operator simply pushes carriage beside hedge. Wilson Associates, 2707 Churchill Dr., Huntsville, Ala. 35801.

Belt tightener

Belt Jack adjusts tension in flat and V-belts and helps maintain proper pulley alignment, says Metrifast (51 S. Denton Ave., New Hyde Park, N.Y. 11040). With 2½" and 5½" extensions provided, the jack has a 4⅜"-to-15⅜" range. Price: $12.95.

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What's New IN HOME IMPROVEMENT

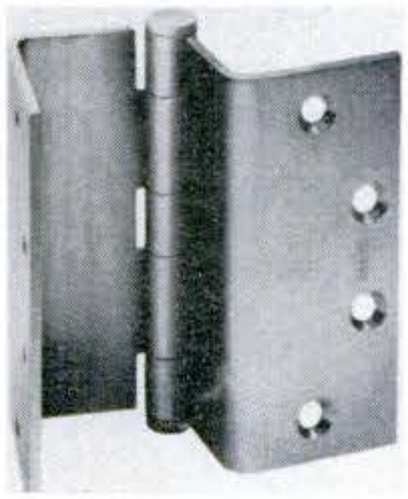
BY R. L. STEPLER

Storage bin

Aluminum indoor/outdoor storage locker is suitable for patios, lawns, gardens, boat docks, and balconies. It measures 48" wide by 36" high by 24½" deep. Price: $50.95. Maker: Capitol Products, Box 69, Mechanicsburg, Pa. 17055.

Vanity

Edge-and-end-glued mixed hardwoods give Chefblok vanity the butcher-block look. A honey-toned stain gives extra drama to grain highlights, says Long-Bell (Box 8411, Portland, Ore. 97207). It's available in a wide range of cabinet combinations.



Hinge

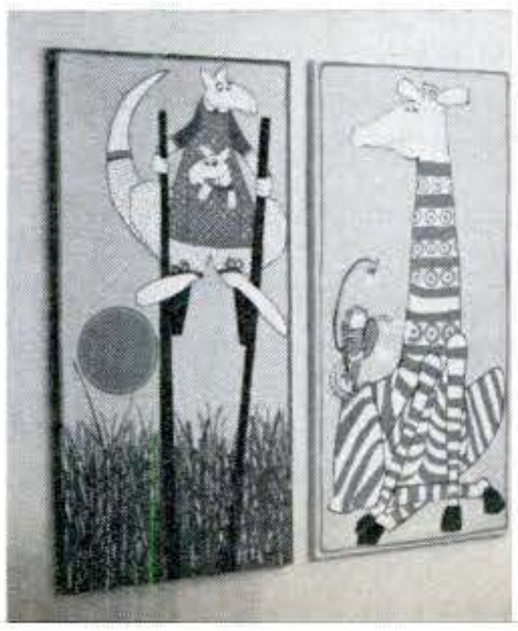
Doors open wide with Swing Clear, Stanley says. The hinge allows two more inches of clear access when doors swing open to 95 degrees. The 3½" and 4" hinges fit existing mortises. Stanley Hardware, Box 1800, New Britain, Conn. 06050.

Weathered-look paneling

Would a rustic, casual interior suit your psyche? Georgia-Pacific's Barnplank paneling has the mellow, weathered look of old barn siding. Realism is heightened by variations of color and pattern in the paneling's Ponderosa pine face veneer. Irregular-width grooves plus knots and splits in the wood contribute to the aged look and give each panel unique character. Barnplank is 5/16" thick and is sold in four-by-eight-foot panels. Georgia-Pacific, 900 S.W. 5th Ave., Portland, Ore. 97204.

Tube light

Supertube swivels 355 degrees to aim light for specific tasks. The fixture takes a 40-watt fluorescent lamp and comes in nine decorator colors. Columbia Lighting, Inc., Box 2787, Spokane, Wash. 99220.



Wall hanging

Whimsical, romantic, modern, abstract, or picturesque Decographics prints are silk-screened on cotton canvas and stretched on a frame. Buy them ready to hang or in kit form. Streamline, 234 W. 39 St., New York, N.Y. 10018.

Insulation

Re-siding? Beef up your home's insulation at the same time by installing Dow's Styrofoam TG before applying the new siding. The ¾"-thick panels are nailed directly to the home's original exterior. Dow Chemical, 2020 Dow Center, Midland, Mich. 48640.

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What's New IN ELECTRONICS

BY WILLIAM J. HAWKINS

Clock/radio

This 0.6-inch-thick radio is small enough to fit in your shirt pocket, but it's a complete AM/FM, alarm-clock portable with a time readout. A liquid-crystal display gives the time in hours, minutes, and seconds. The Panasonic Mr. Thin (RF-016) is $99.95.

Solar calc

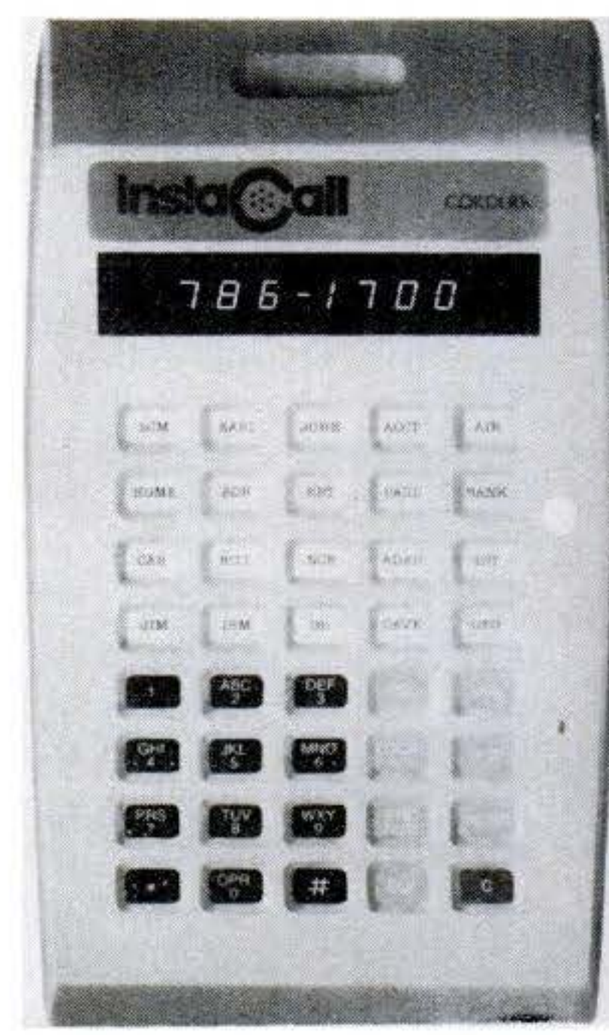
There's no on/off switch on this Teal pocket calculator—it's not needed since there's no battery to run down. It's solar-powered and runs by light—even from a candle. Price, with credit-card case: $39.95. Teal Ind., Victoria Business Pk., 251 E. Victoria St., Carson, Calif. 90745.

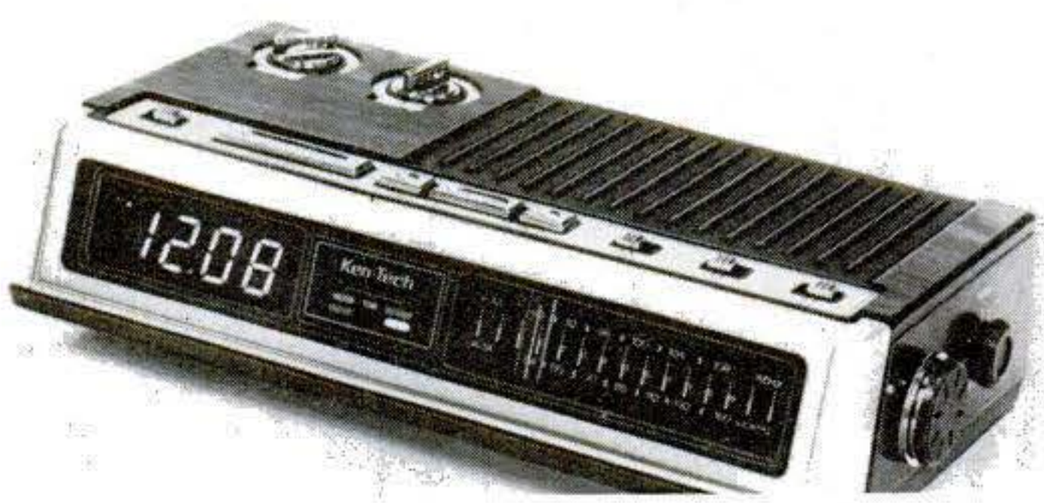
Double vision

How can you watch two TV shows at the same time? Easy—turn on Sharp's prototype Dualvision set. On the 21-inch color screen is a six-inch-diagonal black-and-white picture of another show. Watch both, or use one to monitor the show you're taping. It's not for sale yet.

Pocket dialer

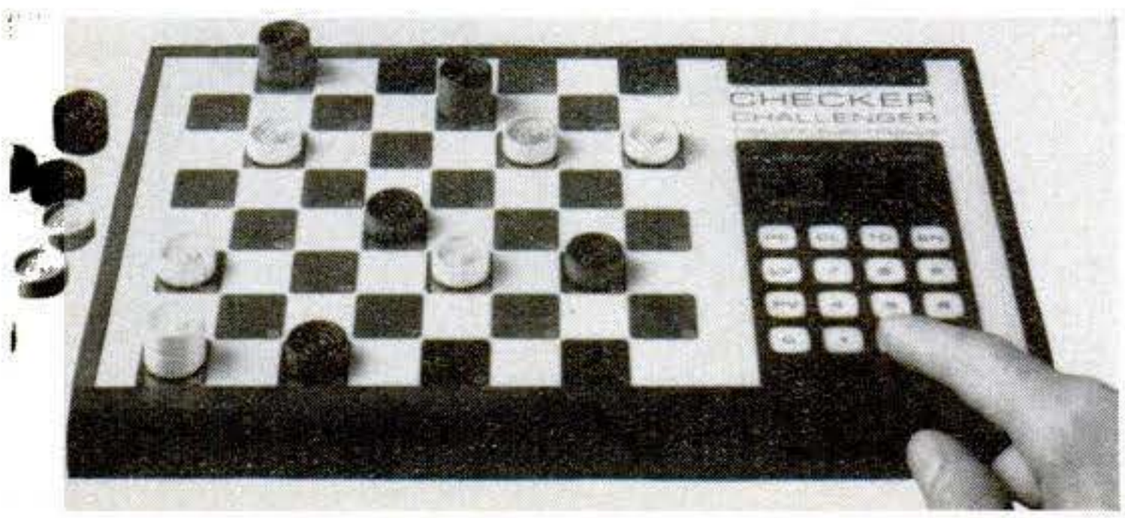
Hold the InstaCall pocket phone unit up to a telephone and it will call any one of 20 preprogrammed phone numbers instantly and automatically. Numbers can be changed or retrieved with a push of a button. It's $129.95 from Cordura, 10 S. La Salle St., Chicago, Ill. 60603.





AM/FM/temp

Flip a switch on this AM/FM clock radio and it displays the temperature in Celsius or Fahrenheit. It shows both inside and outside temps, using two external sensors. Kendale Technology Corp., 814 Ponce de Leon Blvd., Coral Gables, Fla. 33134. Price: $98.



Computer checkers

Enter your move on the keyboard of this Checker Challenger and an internal computer takes its turn—and the game if you're not careful. Skill levels can be programmed in from beginner to pro players. It's $120. Fidelity Electronics, 5245 Diversey Ave., Chicago, Ill.

Storm watch

Severe storms like tornadoes give little warning, but they do create electrical disturbances detectable by this Sears battery-operated alarm. It sounds for dangerous storm activity from up to 30 miles away, giving a 20-minute advance warning. Price: $59.95.

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What's New
FOR YOUR CAR

BY RICH CEPPOS

Diagnostic kit

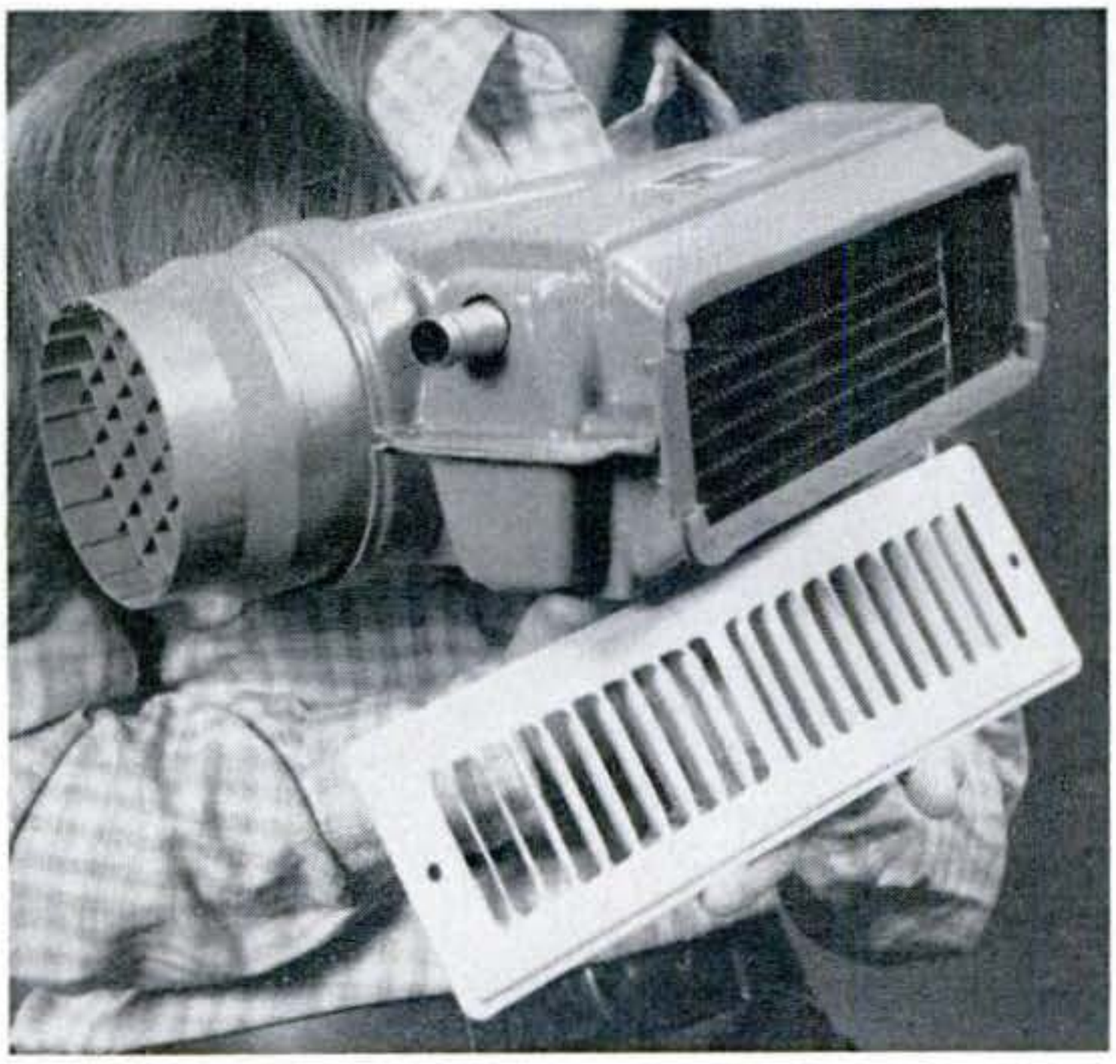
Want to know what's making your car act up? The Diagnostic Kit can help. It includes an inductive timing light, vacuum gauge, compression tester, remote starter switch, and an electrical-system analyzer. Sun Electric Corp., 6323 N. Avondale Ave., Chicago, Ill. 60631. $250.

Electrical tester

Electrical system in a state of shock? Find out why with the Model 540 tester. It checks batteries, wiring, switches, and more. It also works on many home appliances. $29.95 (kit: $21.95). Eico Electronic Instrument Co., Inc., 108 New South Road, Hicksville, N.Y. 11801.

Stronger radials

The aramid-fiber radial belts in the new Firestone Supreme are five times stronger than steel, so they are more resistant to punctures than steel-belted tires, says the maker. The 78 series comes in 13-, 14-, 15-inch rim sizes in whitewall only, ranges in price from $70 to $105.

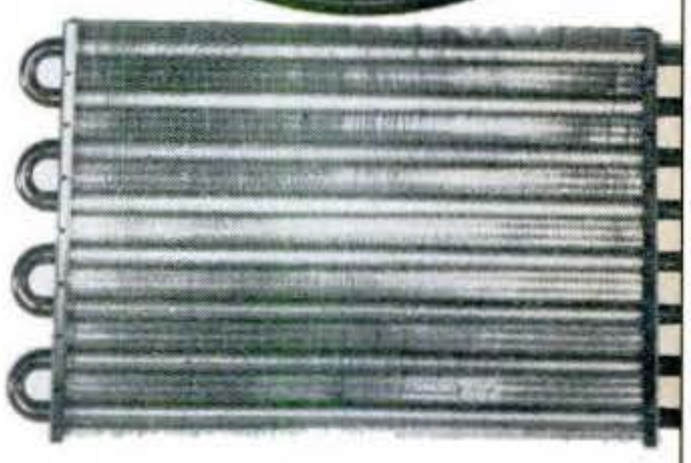


RV heater

Is your RV's cabin like a big refrigerator when driving on cold days? The Warm-Traveler makes it toasty by circulating hot engine water. It automatically shuts down your built-in furnace when it goes on. Basic unit is $78. Ducoh Systems, Box 193, Painesville, Ohio 44077.

Transmission cooler

Keeping your RV's temperature down will help it live longer, says Valley Tow-Rite (1313 S. Stockton St., Lodi, Calif. 95420). The maker offers four transmission coolers for vehicle/load ratings of 8000-19,000 lbs. No special tools are needed for installation.



RV batteries

Maintenance-free RV batteries that are capable of cycling and cranking are available for the first time anywhere from Delco. Previously you needed two batteries: one for starting and one for running accessories for long periods with engine off. Three power outputs are available.

Electronic clock

The LED II electronic quartz auto clock displays the time-of-day, elapsed time, or date. A flashing indicator shows that the clock is working. It can be read in any light and is exceptionally accurate, says the maker (Sparkomatic Corp., Milford, Pa. 18337). Suggested list price: $29.99.

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Portable power

–for home, RV, or vacation cabin

Portable generators produce more power than you might think, but they may not be for everybody

By RAY HILL
PHOTOS BY PETER BRITTON

Last January, on Long Island, N.Y., a severe ice storm left thousands of homes without electricity for several days. Many people had to leave their unheated, unlighted

Generators we tried, left row, front to back: Honda EM 400, Onan 1.7 TN, Honda EG 1000, Kohler 1750, Homelite 3000, McCulloch 1500. Right row, front to back: Kawasaki KG 700B, Kawasaki KG 1000B, Generac 1350, Homelite 1500, Generac 2250, Kawasaki KG 1500B, and, in front of the author, McCulloch 2000. When shopping, inquire about accessories. These vary from wheels that ease portability to voltmeters and more sophisticated voltage-regulating systems. For home use, unless appliances are plugged into the generator, a manual transfer switch should be installed in your home by a licensed electrician.

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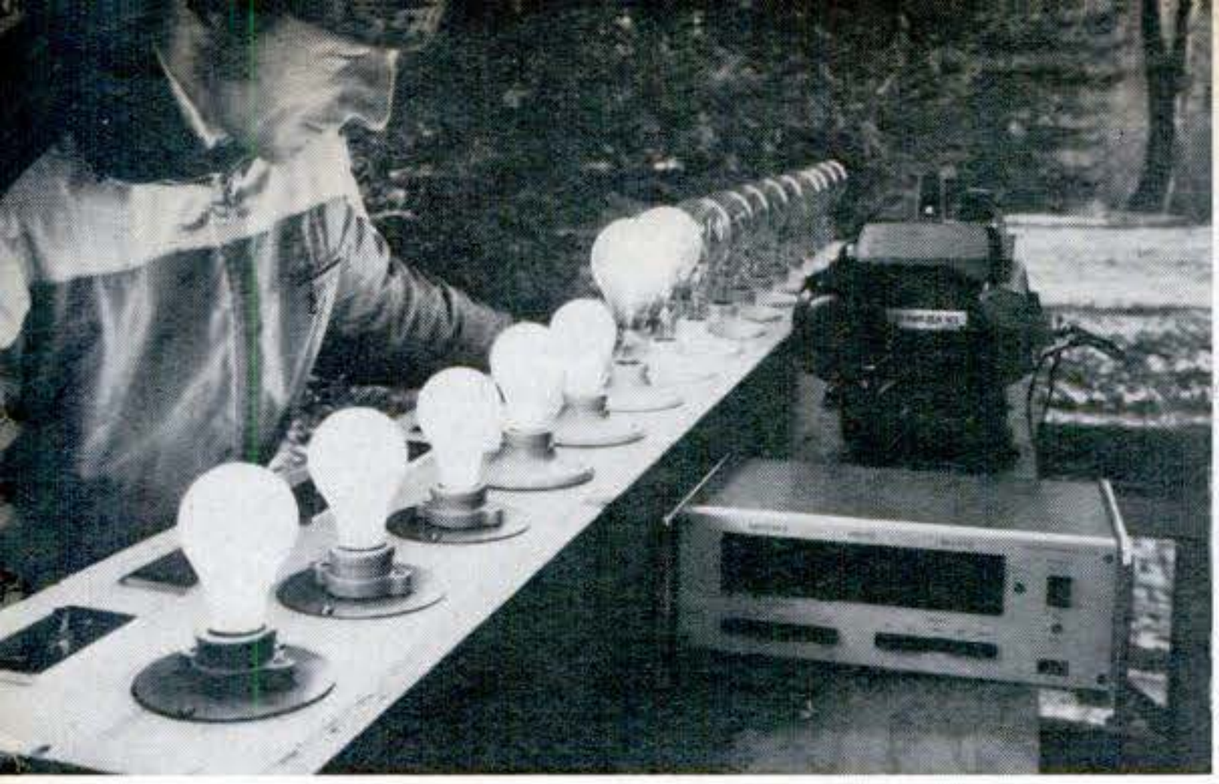
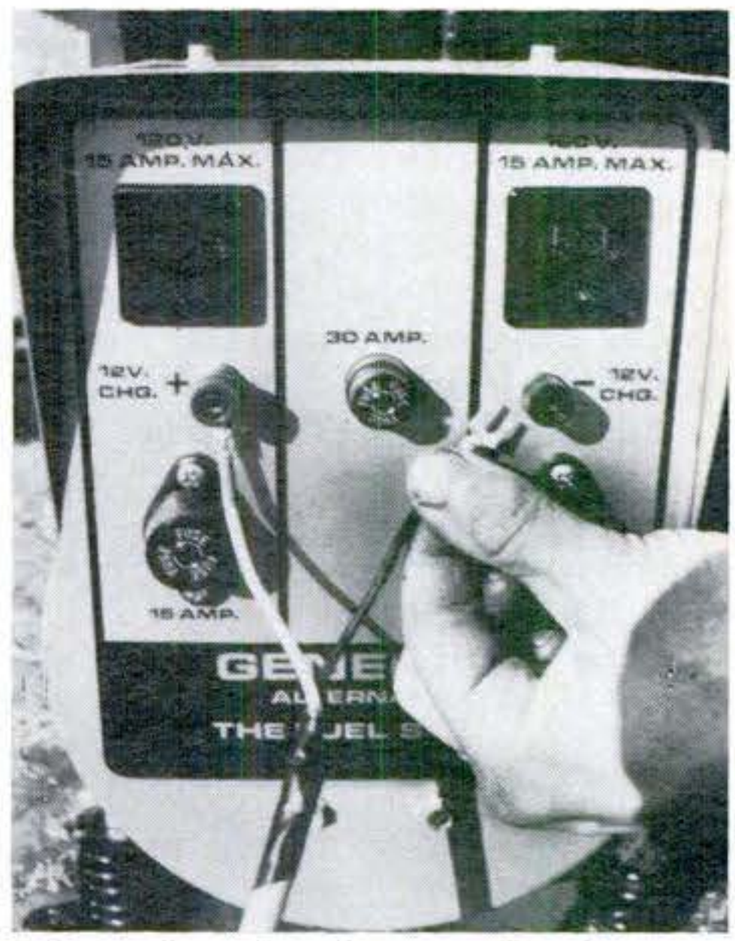


Load panel built by author contains 16 light bulbs—11 300-watt bulbs and five 100-watters. Each has a switch, so load can be varied from approximately 100 watts to 3800 watts. Electrical behavior of each generator in terms of volts, amps, and watts was measured by highly accurate Magtrol 4610 power analyzer, which sells for $2075. Power analyzer was plugged into generator, and load panel or other electrical tool or appliance was plugged into analyzer.

Lightest of all the generators was Honda's EM 400. About 39 pounds—not much bigger than a car battery—it's great for small power demands.

Electrical outlets on these units are just like those in your home. All are easily accessible, and all accept either two- or three-pronged plugs.



DC outlets for battery charging are available on some generators. "Plus" wire goes to the positive battery terminal; "minus" wire goes to the negative.

homes to seek shelter elsewhere. Many others, in order to provide their own electricity, bought portable generators.

Although this unpredictable storm caused an unusual run on portable generators, the trend in sales of these units has been sharply up in recent years. Not only are people buying them for protection against blackouts, but also for their isolated vacation homes, for RV's, and as a source of electric power at remote building sites. Unfortunately, after buying a unit, the owner is sometimes disappointed to discover that the generator doesn't do what he thought it would.

If you've been thinking of buying a portable generator, you've already run up against problems. With the variety available, which one do you buy? How much power do you need? Do the various generators really deliver what manufacturers claim? How easy are they to operate or maintain? Finally, can a portable machine—we arbitrarily set our upper weight limit at 100 pounds—really do the job for the average home, RV, or vacation cottage owner? Or do you need one of the bigger semiportable or permanently installed units?

To answer these and other questions, we contacted seven manufacturers of portable generators: Generac, Homelite, Honda, Kawasaki, Kohler, McCulloch, and Onan. These account for most of the portable-generator sales in the U.S. We tried 13 generators, ranging in weight and capacity from Honda's almost tiny EM 400 (39 lbs. and 300 watts) to Homelite's 3000 (98 lbs. and 3000 watts).

All of these little engines run happily on regular or unleaded gasoline and a good brand of 10W-30 oil. In extremely hot or supercold climates you might want to use a higher- or lower-viscosity oil. (See instructions with your unit.)

They all have rope-start engines, and all started easily, usually on the first or second pull. When starting a small generator, you need to hold it down with one hand and pull the rope with the other. Otherwise you may jerk the generator partially off the ground instead of starting it.

Operating any of the units is easy. After starting the engine, just plug in. Never try to start a portable generator with an electrical load on the unit. Among other things, this makes it difficult or impossible—depending on the load—to start.

How much power can a portable generator produce? We tested all units with a Magtrol power analyzer (see photos) under various load conditions. The most important finding: You can trust the manufacturers' claims. All 13 were able to

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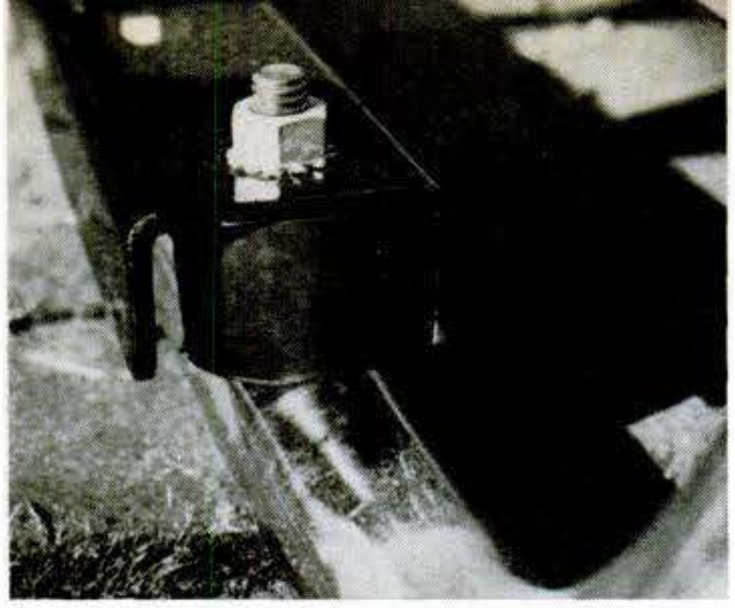

To dampen vibration and eliminate "walking," three basic approaches are used. McCulloch has rubber bushings between carrying frame and generator (left). Generac and Homelite use springs for legs (center). The others use rubber legs. None of the generators exhibited a tendency to "walk" on earth, brick, or concrete. To semipermanently anchor one to the ground, drive stakes into the earth and wire the legs to stakes. Tent pegs work as well as stakes.

produce their maximum rated power—from 400 watts for the Honda EM 400 to 3000 watts for the Homelite 3000.

In fact, all were able to carry overloads for varying lengths of time. The results from an overload ranged from nothing, if the overload is slight, to a blown fuse or stalled engine if the overload is continuous and heavy.

Our testing procedures were fairly simple. First we started each generator, then measured how much voltage it produced at no load. This varied from a low of 115 volts for the Kohler 1750 to a high of 147 volts for the McCulloch 2000 (see table). Then I flipped on the appropriate number of lights on the load panel until each generator was producing its maximum rated output. Voltage was measured again. Voltage at full load measured from 108 volts for Generac's 1350 to 127 volts for Kawasaki's KG 1000B.

Note that all the voltage figures given here are to the nearest volt. Although the Magtrol power analyzer gives a continuous readout in tenths of volts, voltage constantly fluctuated a few tenths, or more.

Line voltage from the electrical outlets in your house may not remain the same, either. For example, I plugged the power analyzer into one of the outlets in my home and monitored electrical output for 15 minutes. It varied from 119 to 125 volts.

The fact that voltage—from a portable generator or from the power company—may vary a few volts is not important. But when output voltage (with no electrical load applied) is significantly higher than 120 volts, as it is with some of these units, it can shorten the life span of some electric motors.

At full load, none of these generators produces enough excessive voltage to be damaging. But if you were using, say, the McCulloch 2000 to power only a pad sander (which draws little current), the high voltage output (in this case 141 volts with the sander running) could shorten the life of the sander's motor. Our table shows voltage output at full load, at heavy load (circular saw), at light load (pad sander), and at no load. This gives you an idea of the voltage each unit puts out under varying loads.

In addition to our panel of 16 lights, we lined up the following appliances for testing: a half-inch portable drill (2.1 amps), a jigsaw (1.8 amps), a pad sander (1.8 amps), portable circular saw (9 amps), portable black-and-white TV (0.2 amps), radio (0.2 amps), vacuum cleaner (10.3 amps), small portable hair dryer (4.2 amps), large non-portable hair dryer (10.9 amps), and an electrical heater (10.4 amps).

The drill, jigsaw, sander, and circular saw were tested under normal use. The drill, with a ¼-in. bit in the chuck, drilled through a ¼-in. steel strap. The sander was used to sand a board. The jigsaw and circular saw cut through a 2x4.

As you expect, all the generators were able to power the drill, jigsaw, and sander, which use relatively little power. And except for the little Honda EM 400 and the Kawasaki 700 B, all were able to power the circular saw. Trying to start the circular saw on either of these two units promptly caused a fuse to blow. That's understandable, since the saw pulls about seven amps just running, and may go as high as nine amps while sawing (depending on how fast you push it through the board). The Honda has only a 2.6-amp rating, and the slightly larger Kawasaki 700 has only a five-amp rating.

We expected this. What did mildly surprise us, however, was that all the other generators were able to power the saw with no problem. Electric motors require a lot more current to start than they do to keep running. Pull the trigger of the saw I was using and you momentarily need about 12-14 amps to start the motor. Then it quickly settles in at 7-9 amps.

The saw's starting surge is greater than a half dozen or so of the other generators' ratings—yet all handled the surge with no trouble. All the generators, in fact, were able to handle momentary surges several amps above their ratings.

Each generator was capable of powering the small hair dryer, and all except the Honda EM 400 and Kawasaki KG 700 were able to power the vacuum cleaner, electric heater, and large hair dryer with no problem. Even the Honda EG 1000 was able to power these three appliances, which draw over 10 amps—more than the Honda's maximum rating. We had expected to blow a fuse, but this didn't happen to the unit for the few minutes that I ran each of these appliances on it.

The radio and black-and-white TV were handled by all the generators, although there was a slight hum in the TV and radio sound, and the picture exhibited more interference than normal. This was probably due to lack of adequate ignition suppression more than anything else. Because of the generators' high voltage at no load, I had to take care not to damage the radio and TV. Using the test panel, I put a load on some of the generators to bring the voltage down to about 120 volts before turning on TV and radio. These generators were the Onan 1.7 TN, Homelite 3000, Generac 1350, McCulloch 1500, Homelite 1500, and McCulloch 2000.

Advantages and disadvantages

Because of their light weight and relatively low cost, these generators appeal to a lot of people. They are capable of running tools and appliances, and provide lighting. All are able to produce their nor-

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mal current rating indefinitely.

But they still may not be for you. The reason? Noise, for one thing. If you try to use one for your RV at a campground, you'll annoy the neighbors. Also, to run it continuously, you'd have to refill the fuel tank and check the oil every few hours. Generators specially designed for RV's are quieter, and run off the vehicle fuel tank or their own propane tanks. And they don't require oil as often, which extends their running time.

How about for vacation cabins? Here again, noise may be a problem. And you've got to deal with the running-time problem. You could rig a larger fuel tank, but then you'd still risk running the small oil sump low and destroying the engine. Oil should be checked and topped off at every fuel-tank refill, which for most of these units is two to four hours.

Of course, if all you want to do is run lights and TV or radio in the evening and maybe some tools in the day, then one of these units may be right for you.

Home emergency use? Yes—with limitations. The biggest drawback is size. The bigger the engine, the greater the electrical output. But as engines and electrical generating assemblies get bigger, they get heavier. The largest-capacity unit you're going to find that weighs under 100 pounds (the most that an average person can realistically carry) probably won't have an output exceeding 3000 watts.

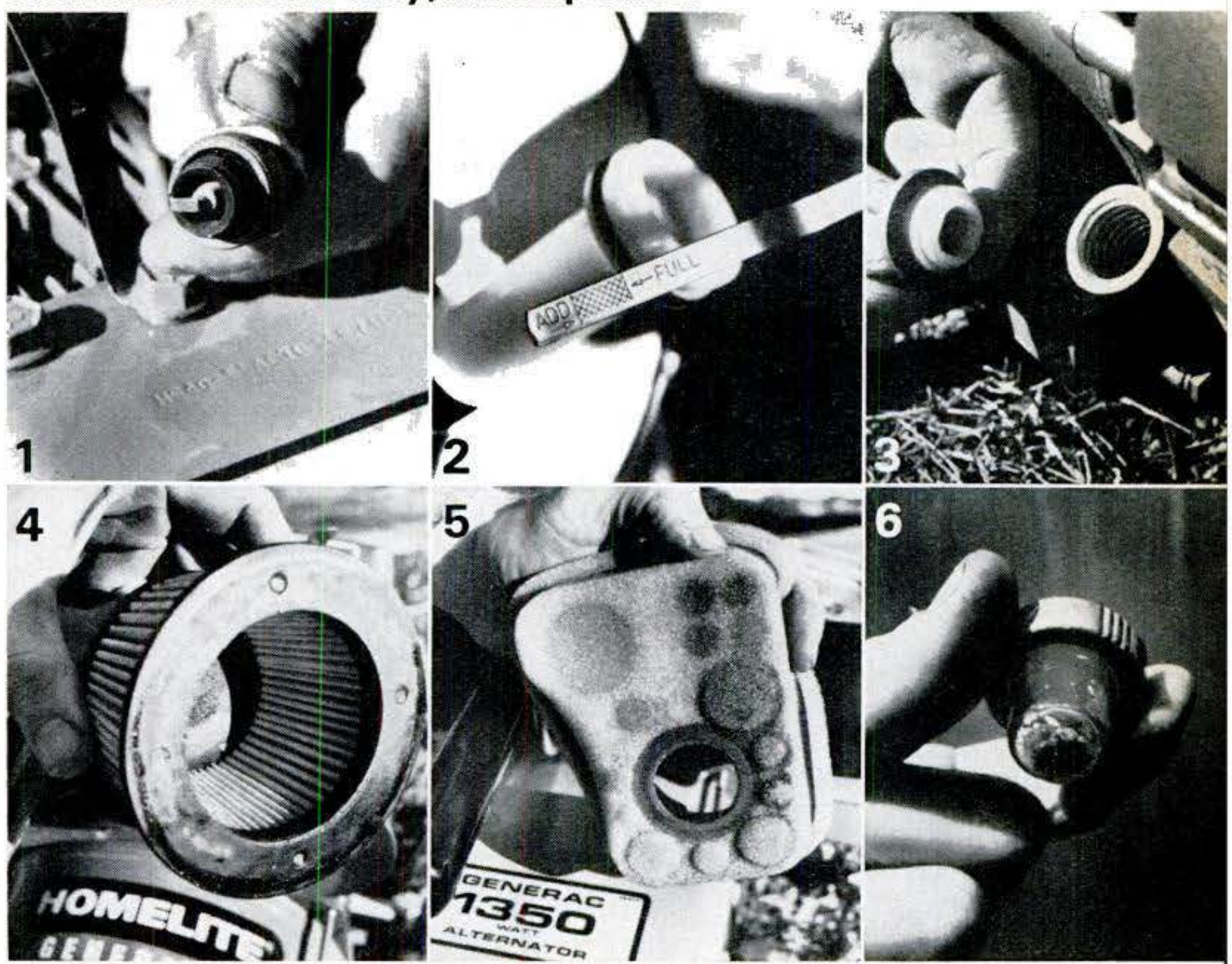
Is that big enough? Maybe. Depending on the ratings of your appliances and the size of the generator, you may have to stagger appliances (run one awhile, and then another). But you certainly can keep the food from spoiling, provide lighting, and perhaps heat, too. In my house, for example, 2000 watts runs the furnace, refrigerator-freezer, and a couple of lights.

When buying any generator, figure out the maximum wattage you'll need at one time (how many tools, appliances, lights, etc. you'll be running simultaneously), then buy a generator with a maximum wattage rating at least this great.

To determine wattage needs of a tool or appliance, check the tag or plate on it that contains the electrical info. If only volts and amps are given, you can multiply volts times amps to get a rough idea of wattage.

Lightweight portable generators are great, as long as you don't expect more from them than they can give. PS

Routine service is easy, but important



After every 10 hours of operation, remove the spark plug, check its condition (1), and regap if necessary. Because of small oil sump, oil reservoir should be topped off, if needed, each time gas tank is filled. Some units have a dipstick (2); others have a plug (3) at the base of the engine. With the plug, the sump is full when oil level is as high as it will go without running from the fill hole. Air filter should also be checked every few hours. Paper-type filter (4) may be cleaned by tapping it with your fingers. When this method no longer works, replace filter. Foam type (5) may be cleaned in solvent, soaked in oil, and reused. On those so equipped, empty sediment from bowl (6) regularly.

Specs and info on models we tested

Make	Model	Rating	Voltage at no load	Voltage at full load	Voltage output while powering sander	Voltage output while powering circular saw	Type of engine	Engine horsepower	Cost ($)	Approximate weight (lbs.)
Generac	1350	120V 11.25A 1350W	133V	108V	127V	116V	Briggs & Stratton	3	424.75	60
Generac	2250	120V 18.75A 2250W	121V	117V	122V	121V	Briggs & Stratton	5	554.75	75
Homelite	1500	120V 12.5A 1500W	141V	124V	135V	128V	Tecumseh	3.5	379	62
Homelite	3000	120V 25A 3000W	138V	125V	132V	130V	Tecumseh	7	569	98
Honda	EM400	115V 2.6A 300W*	124V	119V	123V	—	Honda	.75	299	39
Honda	EG1000	115V 7A 800W*	119V	123V	118V	121V	Honda	3.5	387	64
Kawasaki	KG700B	120V 5A 600W*	126V	126V	124V	—	Kawasaki	2.4	359	55
Kawasaki	KG1000B	120V 7.5A 900W*	126V	127V	123V	125V	Kawasaki	3.4	409	70
Kawasaki	KG1500B	120V 10.8A 1300W*	126V	122V	125V	124V	Kawasaki	5	469	97
Kohler	1750	120V 14.6A 1750W	116V	118V	113V	115V	Briggs & Stratton	4	375	67
McCulloch	1500	110V 13.6A 1500W	139V	111V	135V	124V	Briggs & Stratton	3	379.95	85
McCulloch	2000	110V 18.2A 2000W	147V	110V	141V	134V	Briggs & Stratton	4	449.95	91
Onan	1.7TN	120V 14.2A 1700W	138V	123V	134V	130V	Briggs & Stratton	4	428	70

*Honda EM 400: may be run for periods up to 15 minutes at 400W output. Honda EG 1000: may be run intermittently at 1000W output. Kawasaki KG 700B: may be run intermittently at 750W output. Kawasaki KG 1000B: may be run intermittently at 1100W output. Kawasaki KG 1500B: may be run intermittently at 1600W output.

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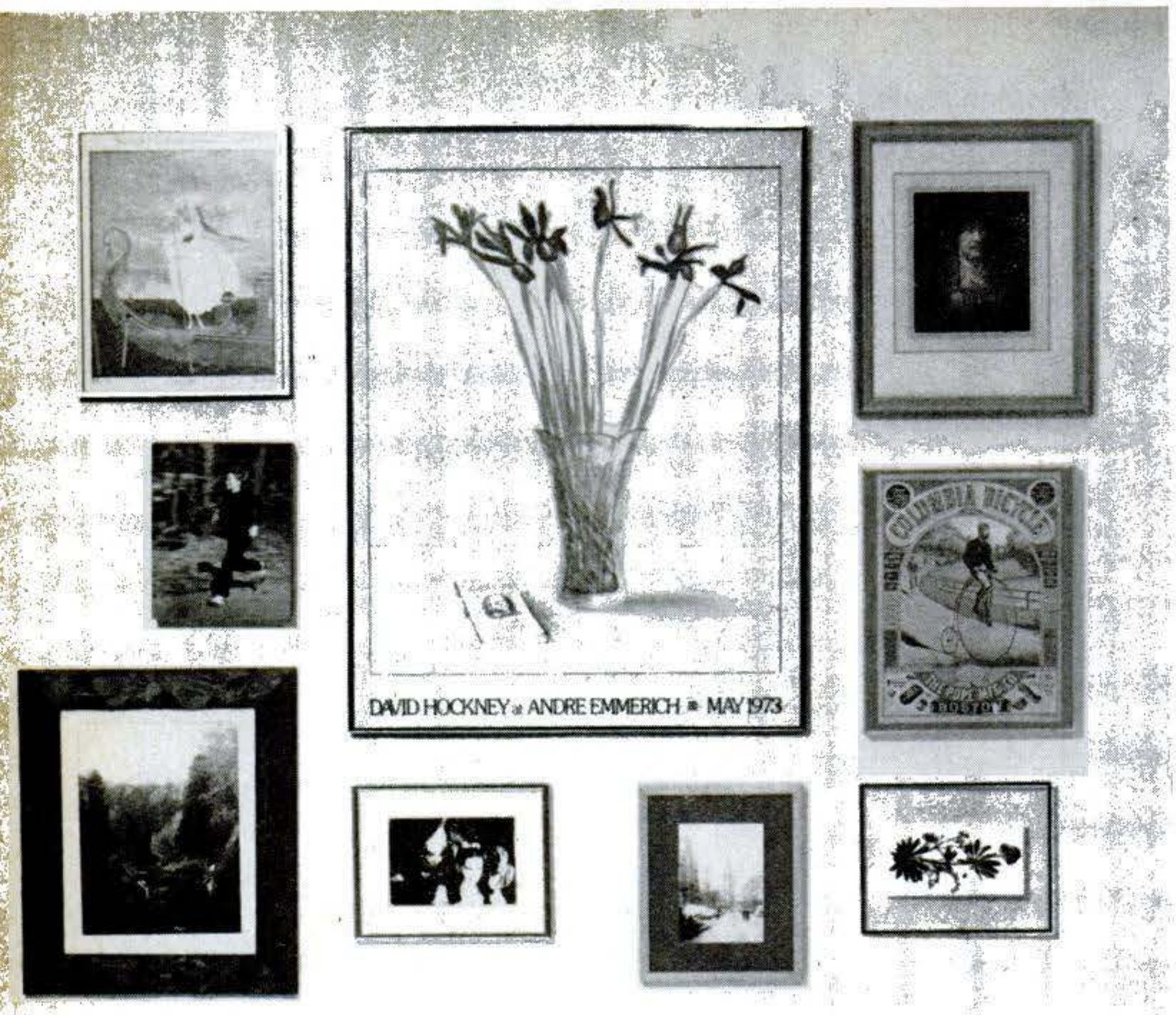


Frame kits

—stylish hang-ups for your pictures

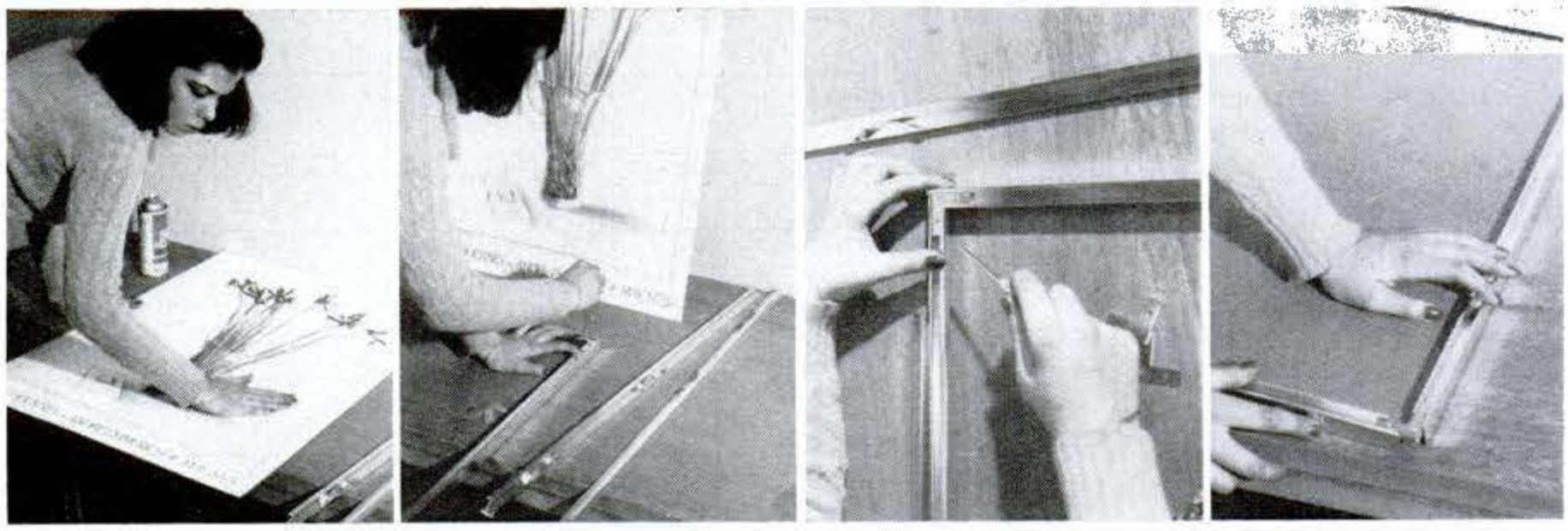
By ROCHELLE CHADAKOFF

I wanted to hang a 24-by-30-inch poster in my living room without waiting weeks or spending a fortune for a custom-frame job. So I decided to do it myself with a $20 frame kit—two pairs of metal sections and glass that saved me at least 40 percent of what a custom frame would have cost. It took only 30 minutes to assemble and hang my museum-quality frame.

Economy isn't the only advantage of these frame kits. You can find them almost everywhere: lumberyards, art stores, and home-improvement centers. A screwdriver is the only tool needed.

This simplicity doesn't undercut their good looks. In fact, New York's Museum of Modern Art and Whitney Museum use the same type of low-cost, versatile frames. Kulicke created the welded aluminum frame for MOMA and later made plastic frames for its permanent photography collection. The company also made metal section frames joined with special hardware for the Whitney and collaborated with Andy Warhol on clear-sided box frames. Now kits make it easy to reproduce these museum frames.

You can buy metal sections for large or irregular-size art, and ready-made metal, wood, and plastic frames for standard-size art (five by seven and 20 by 28 inches). Most ready-made kits include glazing, backing board, and hanging hardware. Companion kits pro-



Four easy steps make Nielsen frame: (1) Spray dry-mount adhesive on backing board, press poster smooth. (2) To join sections, insert right angles into grooves, tighten screws. (3) Slide glass and art into frame. (4) Connect top, squeeze clips between frame and art for tight fit.

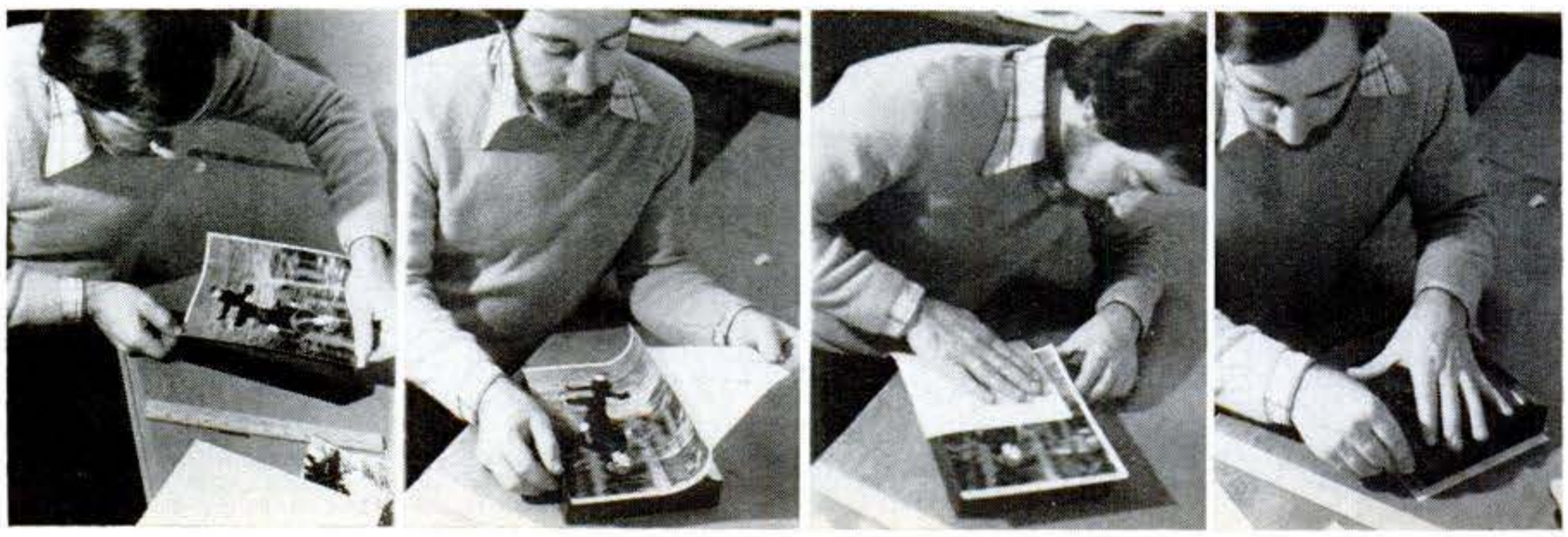


Photo-mount boards add depth to photos, eliminate dry-mounting. (1) Peel corner of adhesive backing off to tack photo in place. (2) Pull the rest off while pressing photo down. (3) A firm hand insures a tight fit. (4) Trim edges. Photo-Pro-Frame clips to others for collages.

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vide glazing and backing board for metal section frames. You sandwich the art between glazing and backing and slip it into the frame. Frame assembly is easy, and all hardware is provided.

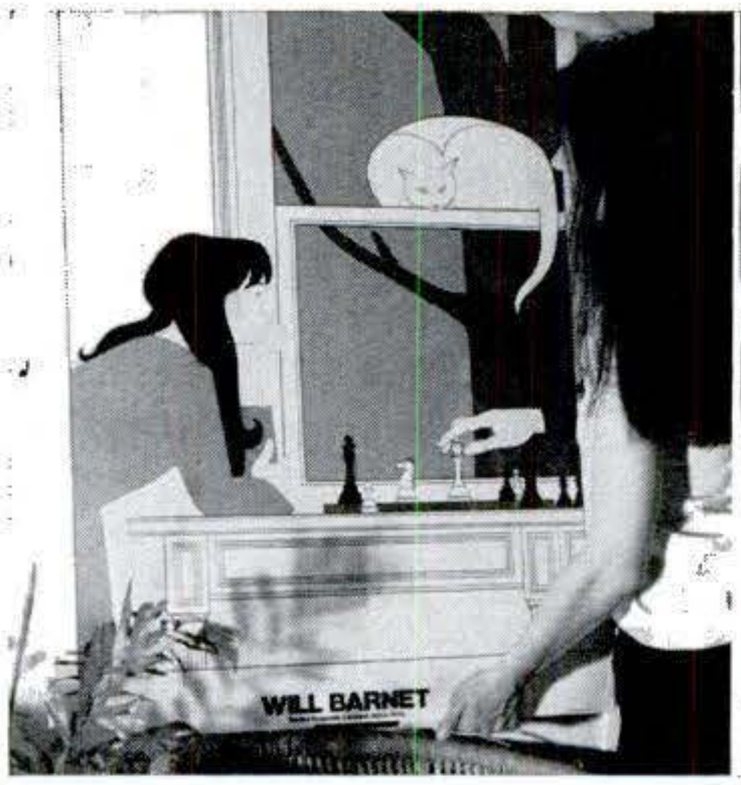
Kit prices reflect size and details. Most metal and wood frame kits use the cheapest glazing—glass. This can be too heavy and fragile for large works, and light reflected by the glass can obscure the art. More expensive nonglare glass (available from Weber or at art stores) will cure reflection problems, but the etching may obscure fine detail. Lightweight plastic is durable, but it scratches easily. Kulicke uses expensive acrylic in all of its frames because it's an extremely clear and protective glazing. Most frames have rabbets roomy enough for a mat. Some kits include thin, neutral-toned mats. Since they can gracefully focus a picture and add the finishing touch to a frame, precut mats in burlap or rich finishes are often worth the extra investment.

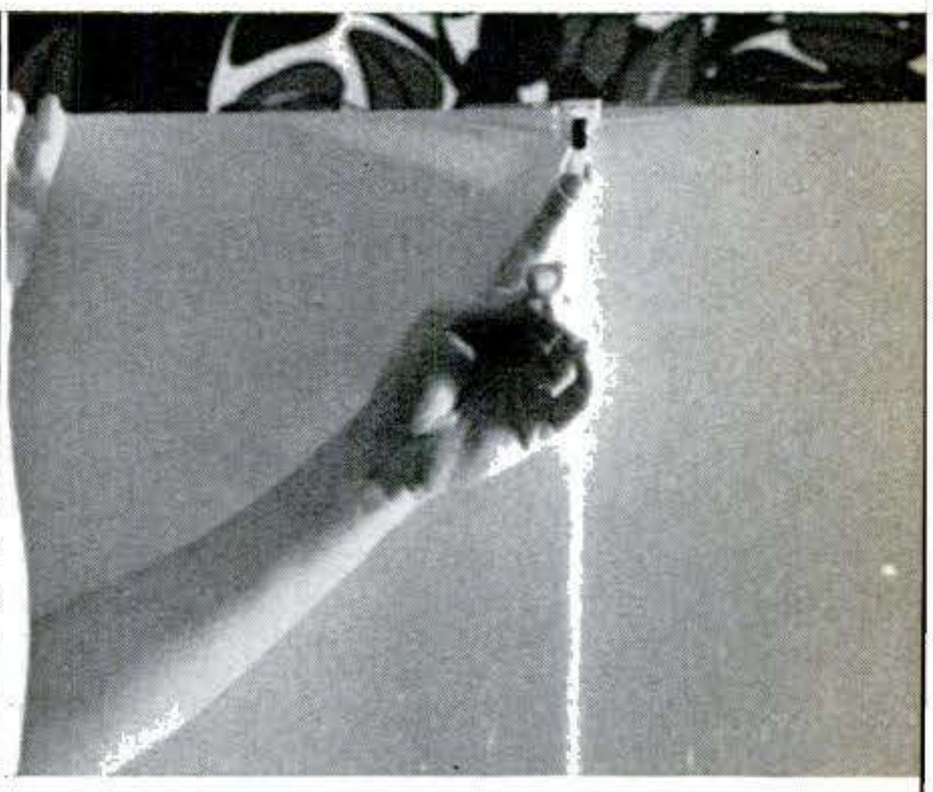
Shopping around, I found that most stores discounted kits 30 to 50 percent from list price. PS

WHO MAKES 'EM:

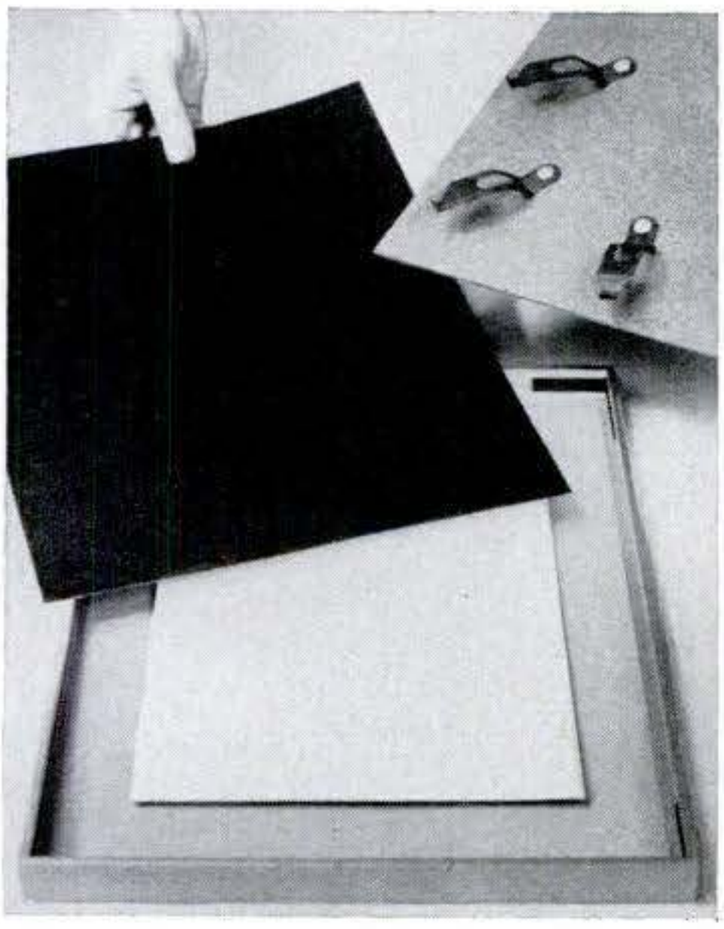
Baia Photo Optical Corp., 9353 Lee Rd., Jackson MI 49201; **Barclay Industries,** 65 Industrial Rd., Lodi NJ 07844; **Coda,** 196 Greenwood Ave., Midland Park NJ 01432; **Condecor** (Decorel), 444 E. Courtland St., Mundelein IL 60060; **The Frame Company,** 33 Hope St., Jersey City NJ 07307; **Leader Frames,** Brandess Brothers Sales Co., Inc., 4847 N. Western Ave., Chicago IL 60630; **Nielsen,** Townsend MA 01469; **Kulicke Frames Co., Inc.,** 636 Broadway, N.Y. NY 10012; **Photo-Pro Frame Co.,** Box 2689, Laurel MD 20811; **Structural Industries,** 96 New South Rd., Hicksville NY 11801; **Weber Co.** Wayne and Windrim Ave. Philadelphia PA 19144.

Anodized metal frames come in many finishes and colors. An 11-by-14-in. frame costs about $11. Shown here (top row): The Metal Frame; Structural's Frame-ups; rear view of Kulicke frame; (bottom row) Weber's companion kit, Frame-Mate; the Leader Frame; and Barclay's Kwik-Frame.



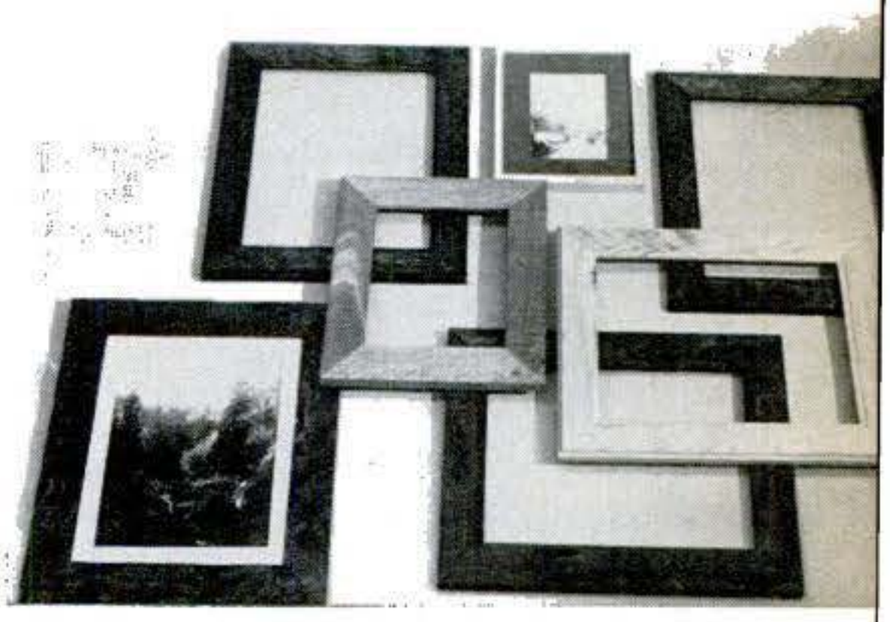


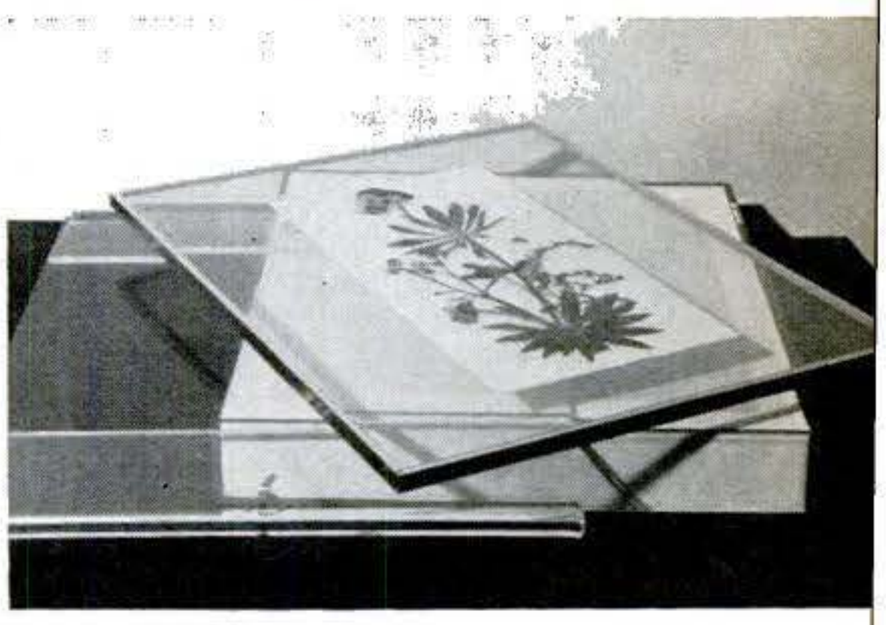
Weber's Braquette ($3.95) and glass give this 30-by-40-in. poster frameless protection. Self-hanging Braquette is a pair of 4-in. channels on Lexan suspenders that adjust to any size from five to 40 in. Extra cord threads through channel and locks in place. Two Braquettes will support heavy art.



Extra features of a Leader frame include cushion-bordered glass resting in a sturdy aluminum frame; textured, reversible mat; masonite backing board with double-duty spring clips (fasteners and hangers) that make assembly a snap. A 20-by-24-in. frame costs $33.

The Wood Frame (from The Frame Co.) and Kulicke's clean-profile Woodline and Complete Collector with an elegant Louis XIV molding are shown in the photo above. Barclay's rustic oak, walnut, and barnwood frames (top, right) need glazing, but at $9 (for 11 by 14 in.) they're still cheaper than custom frames. Plastic frames (right) wrap around art, thrust it forward, or sandwich it between attractive trims. An 11-by-14-in. frame is about $8.50. Kulicke's Trap Frame (top) is the most expensive at $20. Other profiles are Baia's box frame and sleek, acrylic The Frame.





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home-improvement ideas

You'll find useful projects and materials to improve your home's life and livability in the 20-page special section that begins here. We lead off with unique room dividers that do more than divide: They also provide your choice of home office, clever display shelving, storage for dining table and chairs, and more. Other features, tagged with the symbol above, include:

- **Exterior stains**
Are they the best finish for your home? Read this story and decide for yourself. You'll also learn what types of stains are available and how to apply them. In "Preservative Stains," a companion story, you'll find out about this special type of finish.

- **Watering awning**
Here's how to give those hanging baskets of plants and flowers their daily drink—the easy way!

- **Three steps to a lively sundeck**
Spruce up a drab deck with lush, grass-like outdoor carpet, plus a new railing that's topped off with a clever planter.

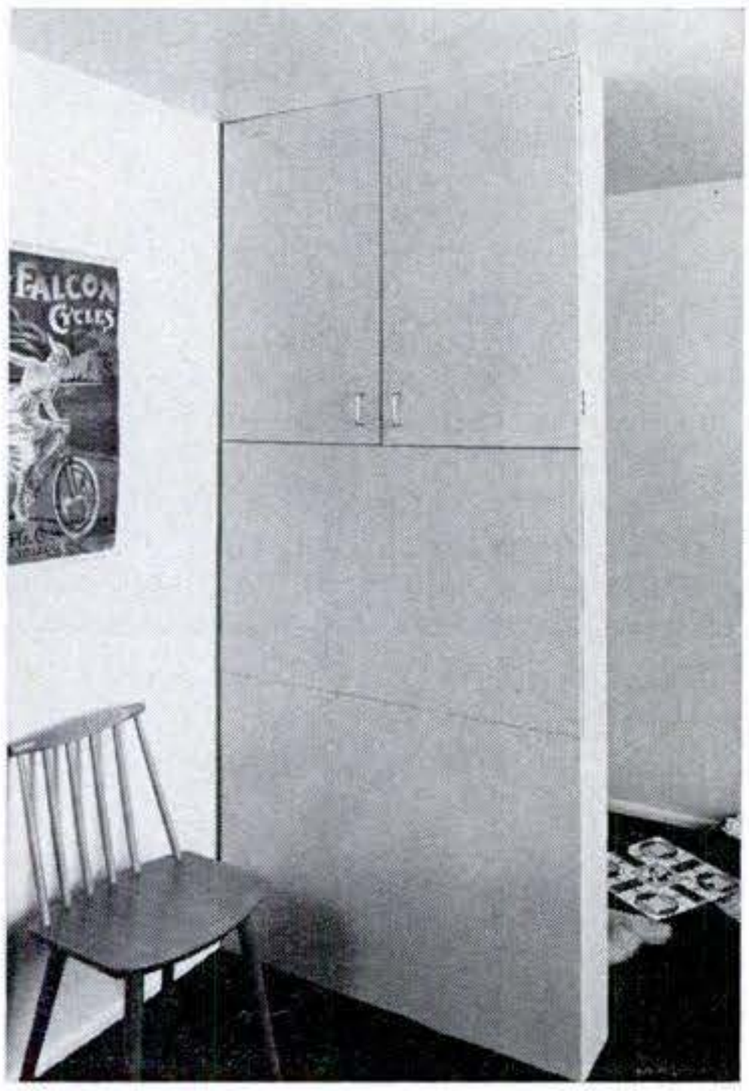
- **Tile-setting patterns**
Ceramic tiles don't have to be laid in straight lines. Other patterns can change the look and simplify problem installations. Here's how, with complete do-it-yourself instructions.

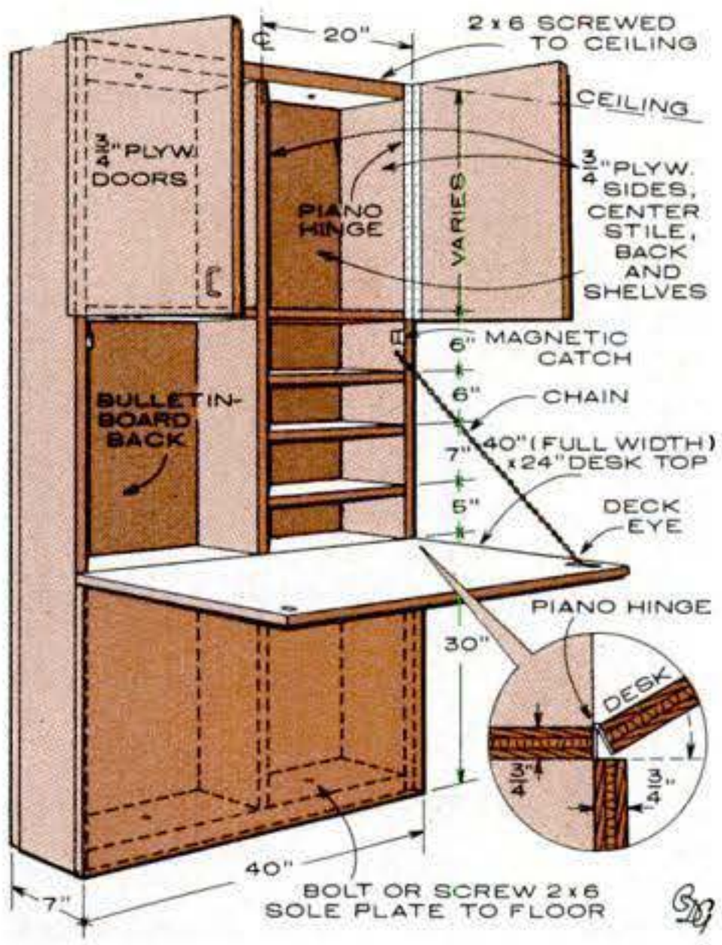
- **All-metal house**
A revolutionary new house that goes up like an erector set may set a trend for homes of the future.

- **Leisure-home plan**
Complete construction plans are available for the house we've used as our home-improvement symbol, above. For details, turn to page 136.

Skinny dividers
do more than partition a room

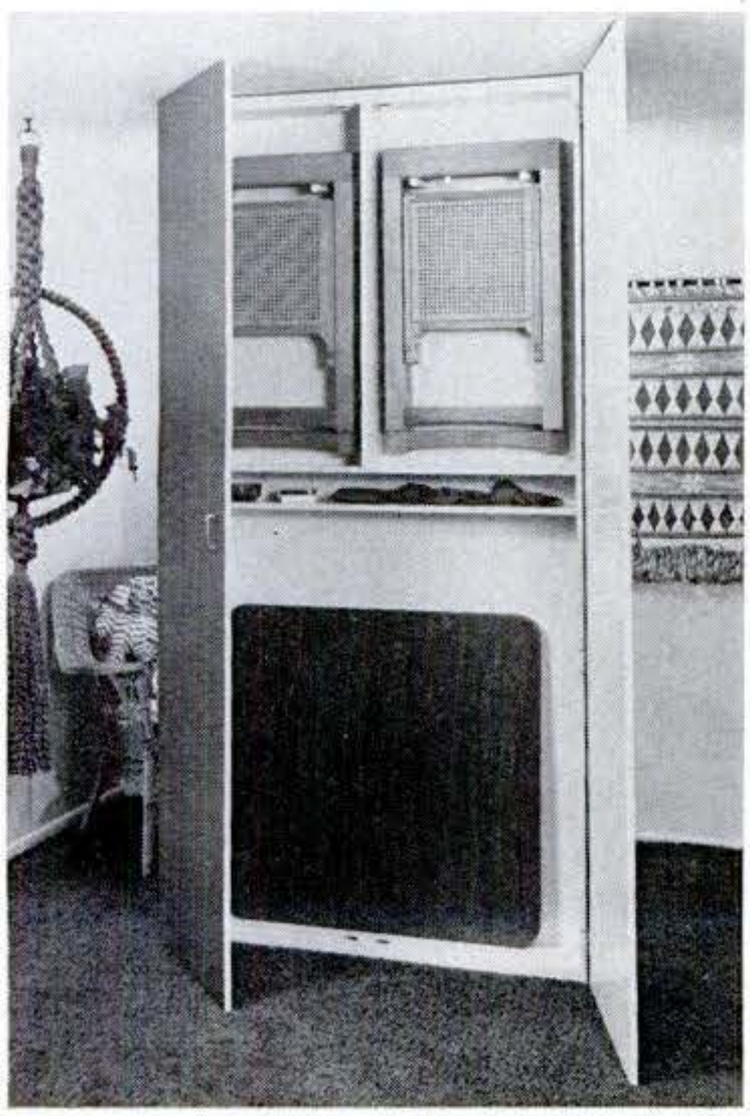
Fold-out desk divider

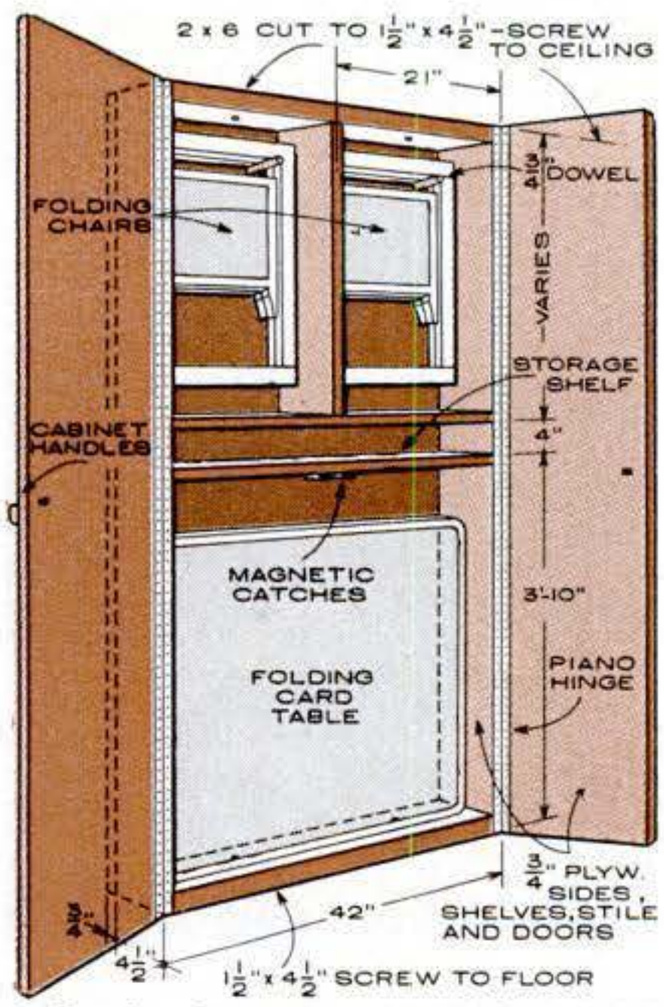




Bright colors enliven this divider whether it's open for business (facing page) or closed for the night (left).

Dining divider





Subdued colors give the dining divider a sophisticated look. Adjust dimensions in sketch to suit your table and chairs.

These great dividers, no wider than a wall, open up to reveal hidden treasures

By RICHARD STEPLER
DESIGNS BY LES WALKER

In profile, these partitions appear to be merely that: dividers that separate areas in a room. But like clever Chinese puzzles, they open up to reveal hidden functions:

- A drop-down desk plus plenty of storage for paper and supplies. You could even attach a portable typewriter to the desk, as we've shown in the color photo.
- A divider that stores a folding dining or card table and four folding chairs. Normally closed (see color photo), this handsome divider frees an area otherwise reserved for dining, games, or other activities.

Since the dividers stretch from floor to ceiling, they must be built in place (otherwise you'd have to allow tip-up room). You do this by first lag-bolting 2x6's to the floor and ceiling, then filling in with plywood. The dividers are designed to be built of 1/2", 5/8", or 3/4" APA grade-marked A-B, A-C, or MDO plywood.

Want to attach a slim portable typewriter to the desk top? Measure the typewriter and adjust the depth of the divider and the size of the bulletin-board recess accordingly. Similarly, for the dining divider, first measure your folding table and chairs and dimension the unit to accommodate them. PS

For more skinny and not-so-skinny dividers, turn the page

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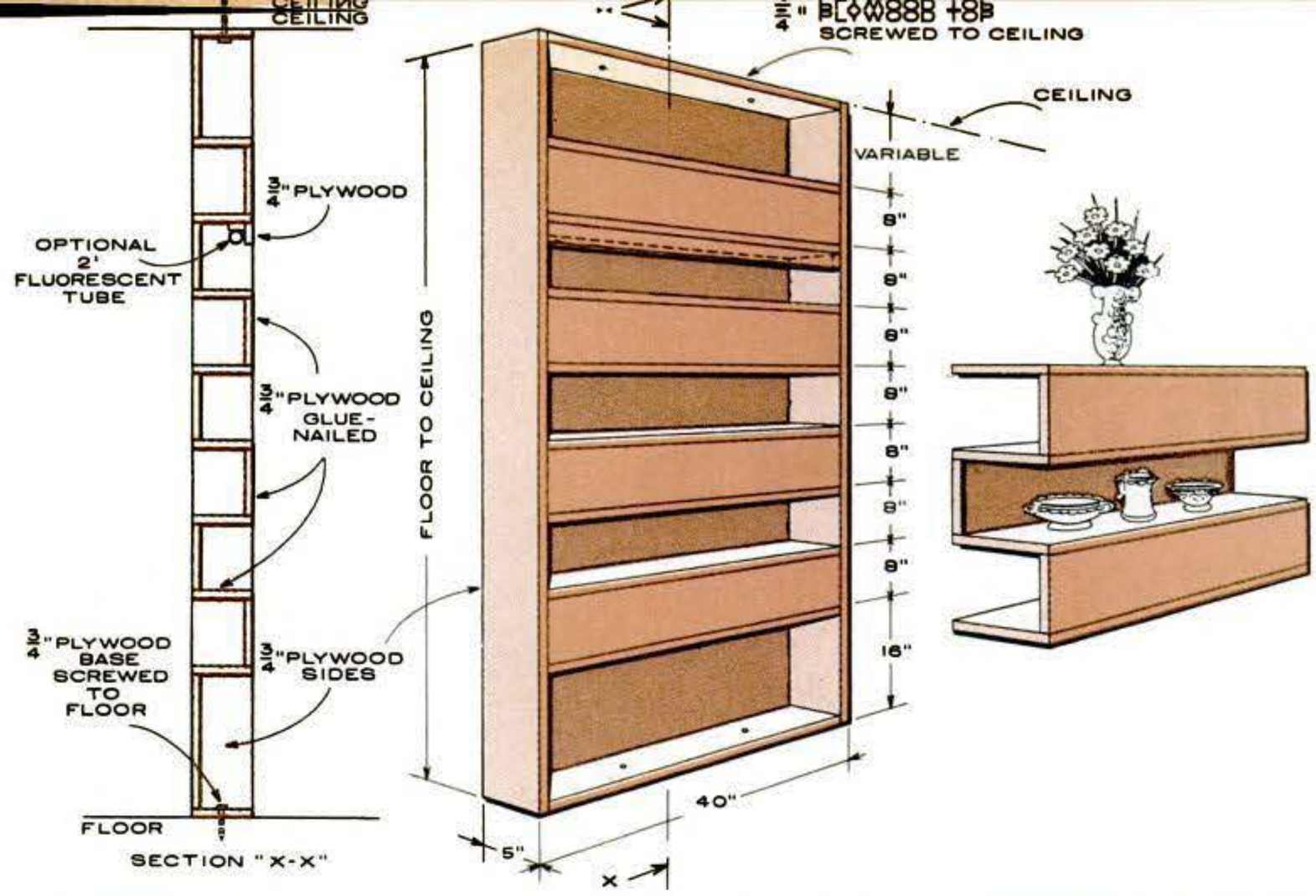
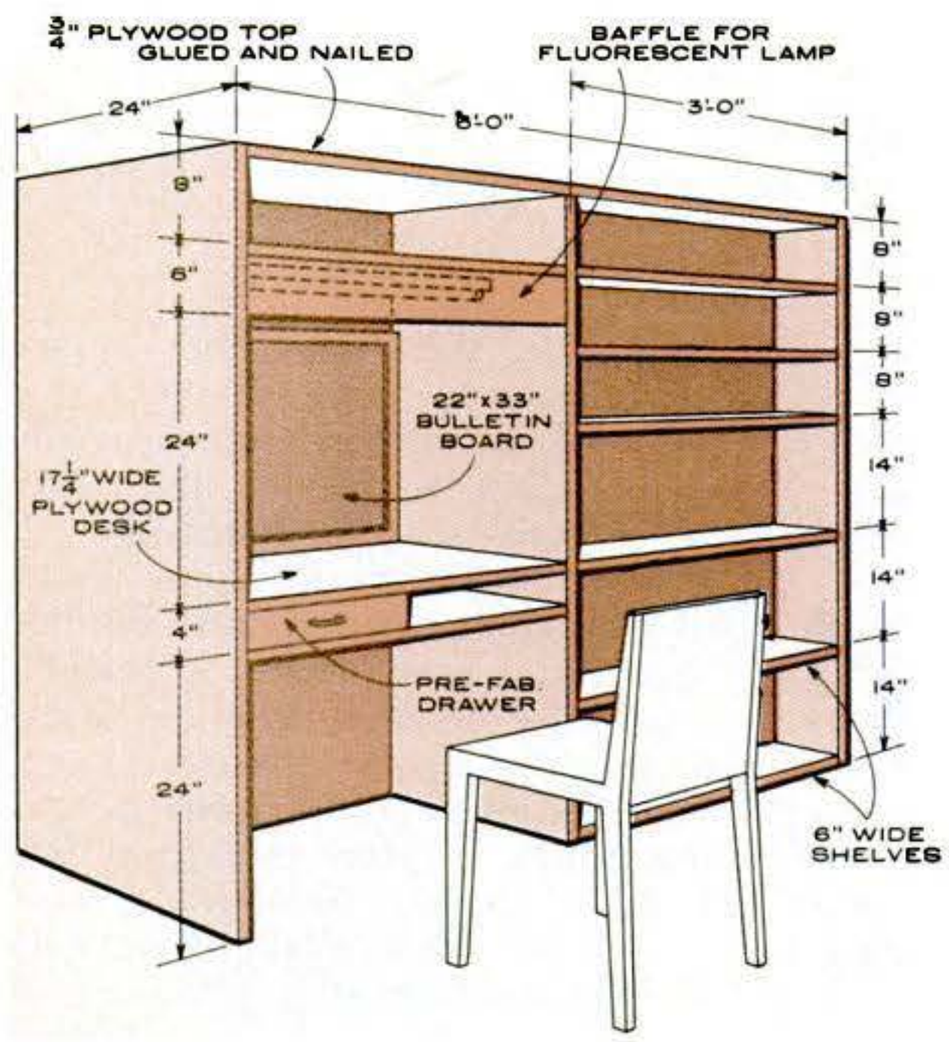
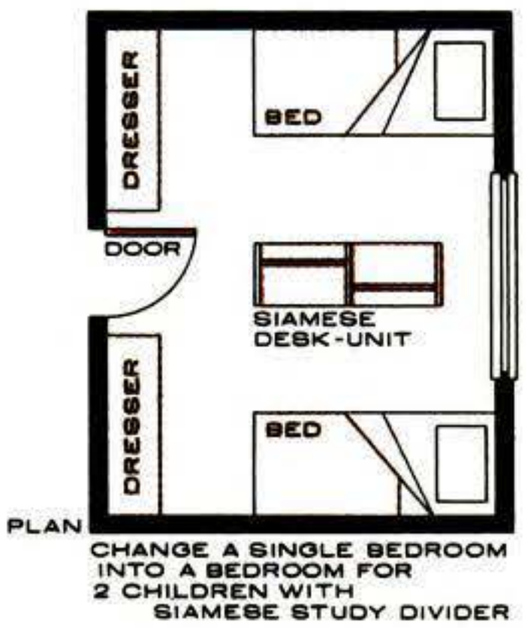


Skinny divider for display shelving

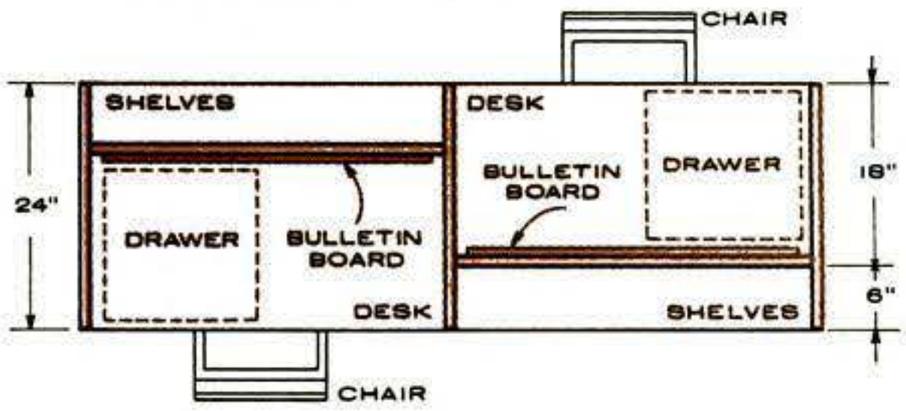
Have a collection of *objets* you'd like to give the VIP treatment? Serpent-like, this skinny divider winds back and forth, from floor to ceiling, providing display shelving on both sides. Why the two-sided arrangement, rather than shelves on one side? The wide band between each shelf separates and sets off objects placed on them for a truly stand-out display. Optional: fluorescent tubes concealed behind valances. Dimension this unit to suit your collectibles.

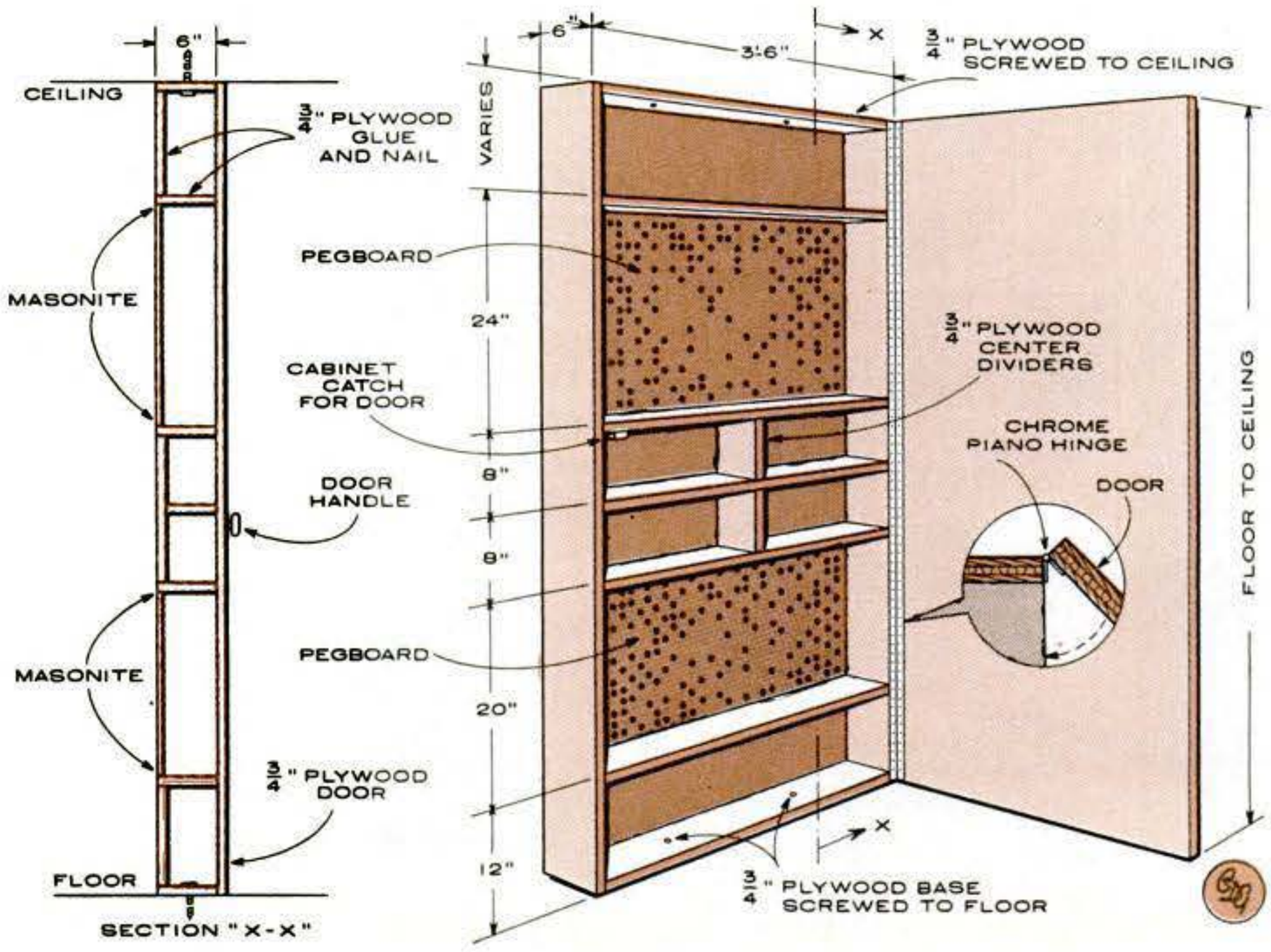




Siamese study divider for the kids' room

With the Siamese study divider, two children get "private" bedrooms, plus his or her own study desk and shelves. This divider is not so skinny—but it's still only two feet wide. We've shown it nine feet long; you can increase or decrease this dimension to suit your space requirements. And, unlike the other dividers shown on these pages, this one is *not* floor to ceiling. So you could build it in your shop and move it into place.





Paint and tool storage divider

This divider provides plenty of perfboard storage for your hand tools, and probably for most of your portable electrics as well. Tuck away such items as paint, nails, and screws on the shelves. It could screen a corner of your shop where you'd like an area for sanding or spray painting. Or the divider could simply be installed in a garage where there isn't space for deeper storage. Want security, too? Add a lock.

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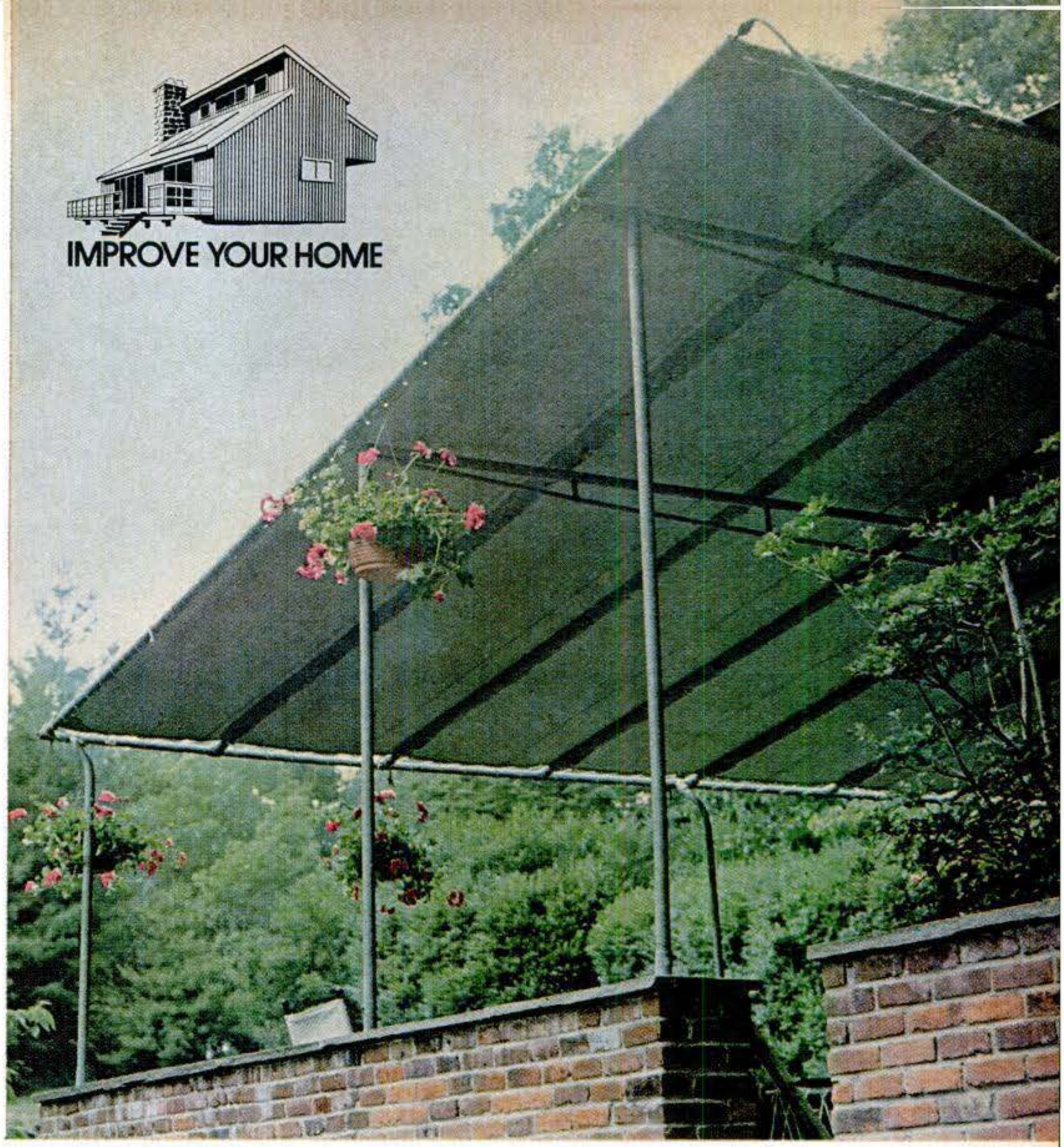
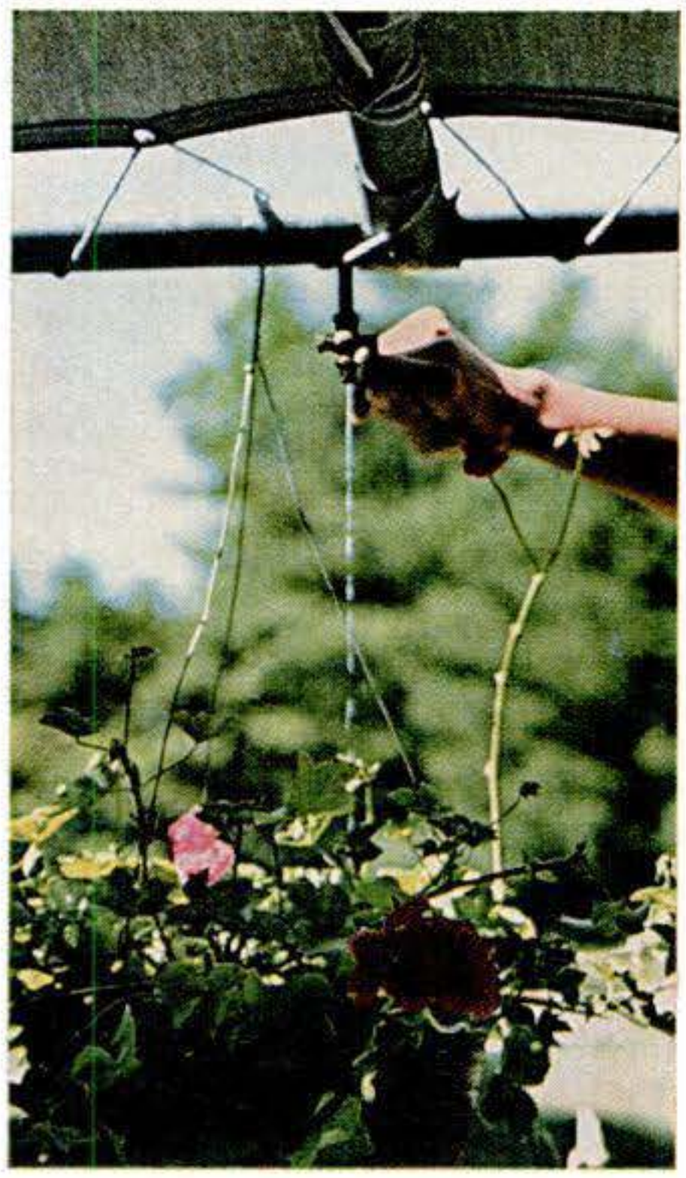
Watering awning

gives plants a daily drink





Hanging plants are watered automatically with water piped through awning framework (above). Garden hose (upper right in above photo) connects frame to outside faucet. Petcocks installed in awning framework above each basket (left) control flow of water. Flow can be adjusted as plants' needs change.

By NANCY CHUTE

Every evening at six the hanging baskets on Fred Sinon's Connecticut terrace get a four-minute drink —even when Fred is out of town. Automatic watering systems aren't new, but Fred has devised an ingenious one using the framework of galvanized pipes that supports his terrace awning. He's rigged up a connection from the outdoor faucet so water runs through the hollow pipes and out spigots installed above each basket. A timer turns the water on and off.

For very little cost handy gardeners can copy Fred's technique or adapt it to fit their particular kind of terrace planters. An automatic setup not only saves time but lets absentee and forgetful gardeners enjoy the beauty of hanging baskets, which generally need daily watering in hot or windy weather.

"I was figuring out a way to run irrigation hoses along the awning frame to each basket when it suddenly dawned on me that the frame itself was pipe—hollow, obviously." What his wife calls "Fred's Rube Goldberg invention" quickly took shape.

At the junkyard Fred got a time-control unit from the freezer section of an old refrigerator and mounted it in a metal box on the house next to the outdoor faucet. An ordinary lamp and appliance timer could be substituted. The timer is wired into a solenoid valve which Fred installed on a T-joint behind the outdoor faucet. This valve, available from hardware or plumbing-supply stores, turns the water on and off electrically. The T-joint permits use of the faucet at all times. The area around the box and electric wiring is sheltered by a roof overhang, and Fred tacked a small metal flap over the solenoid valve for added protection.

To reduce the volume of water flowing to the awning pipes, he installed a hand-operated petcock downstream of the solenoid valve. The T, with its solenoid and petcock, is connected by a length of garden hose to the end of the awning framework. Fred drilled a hole in the end of this pipe and then tapped (threaded) the hole so an adapter for the hose fitting could be screwed into it.

For this kind of work Fred's mechanical-engineering background was a big plus. Others may need a plumber here and for the next step —installing petcocks in the pipe above each hanging basket to control the flow of water. By doing it himself Fred was able to keep expenses under $25.

It would be possible, Fred notes, to simplify the system by merely drilling holes in the pipe above each basket: small holes for the first, and progressively larger ones toward the end of the pipe. But petcocks are more accurate and also allow him to adjust the water flow to each plant's changing needs during the growing season. Once the petcocks are installed, each is adjusted for a gentle stream of water.

When Fred first tested his inven-

Continued

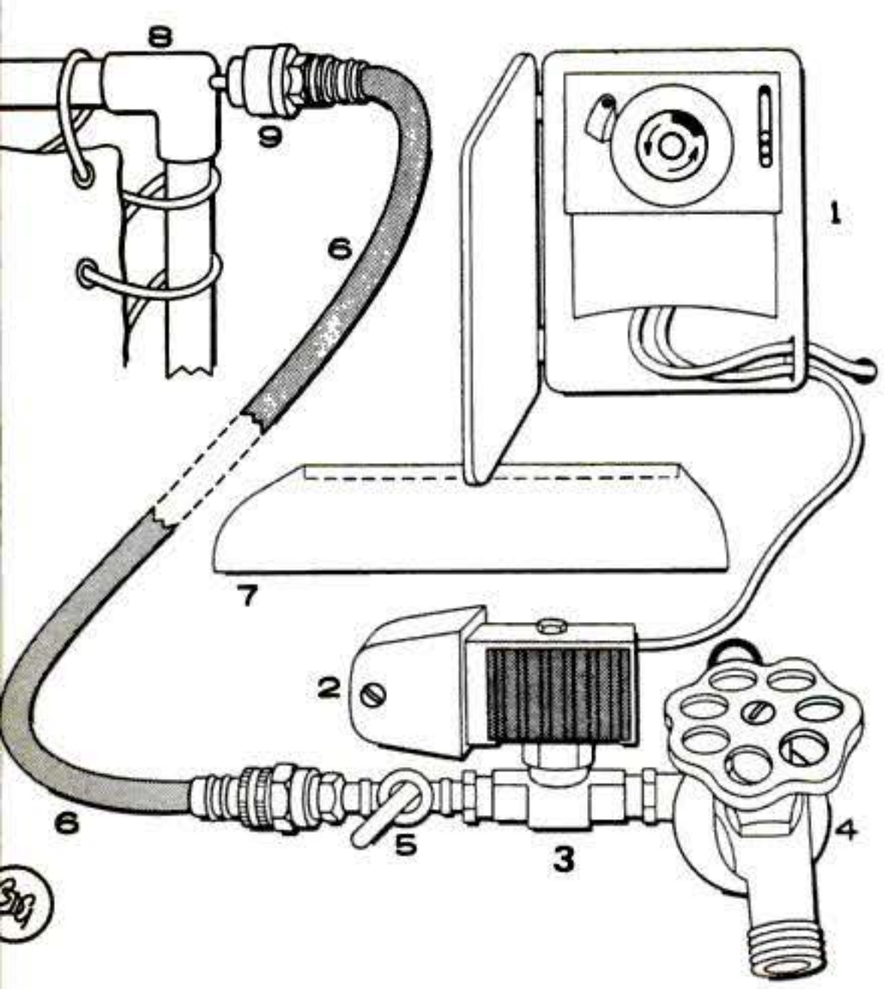
tion, water spurted from every joint; after all, an awning frame isn't built to be watertight. Undaunted ("You don't live in the West Indies for years without learning how to cope"), he wrapped dripping areas with strips of inner tube, holding them firm with hose clamps. Now, all is dry except for one stubborn joint above a support.

The timer is set for six p.m., running for two minutes. Actual watering time is more than twice that, since water remaining in the pipes after shutoff continues to trickle out till the pipes are drained. Fred points out that a freezer timer has many settings, so plants can be watered for brief intervals several times a day if desired—a useful idea, also, if you want to set up a mist system.

Guests relaxing under the blue awning on the Sinon terrace don't notice the slight click at precisely six o'clock when the timer trips the solenoid valve. Half a minute elapses before a thin trickle of water falls from the first spigot onto the basket beneath it. Soon all five spigots are streaming. Water splatters noisily into the baskets and drips to the ground below.

Conversation stops; all eyes goggle at the unexpected waterworks, and the occupant of the seat beneath that leaky joint jumps aside.

"I really didn't do this to get attention," Fred tells his guests. "I did it because I'm lazy." PS



System setup: Timer (1), in box on house, is wired into solenoid valve (2) on T-joint (3) behind faucet (4). Hand-operated petcock (5) reduces water volume flowing through garden hose (6) to awning framework. Metal flap (7) protects solenoid. Hole is drilled in corner of awning framework (8) and tapped for an adapter for garden-hose fitting (9).

IMPROVE YOUR HOME

Exterior stains

Best finish you can put on your home?

Want beautiful protection that won't blister, peel, or crack? You can't beat stain

By A. J. HAND

Owning your own home is one of the great American dreams. But that dream can turn into a nightmare if your house is haunted by chipping, peeling, blistering paint. You spend so much time scraping and repainting that you never seem to have any spare time to enjoy your home.

That's why more and more people are deciding not to paint their homes. They're turning instead to stains—and increasingly, to the new latex types. In 1973, only a few manufacturers were making latex stains. Today they number over a dozen. One maker, Glidden, reports that its sales of latex stains have increased by over 15 percent a year for the past four years.

It's in the wood

When you turn to stains, what do you get? A good stain can protect as well and last as long as—even longer than—house paint. This is especially true on rough-sawn or weathered wood because these surfaces absorb stain very well. A good stain will not chip, blister, alligator, or peel. It can't because it is largely *in the wood*, not on top of it like a film of paint.

Sure, stains weather and need recoating just as paints do. But since they won't crack or peel, there's no need for a lot of scraping, sanding, and other prefinishing operations. When the time comes to recoat, you just make sure the existing stain is clean and start staining. Oil stains over smooth wood may need recoating in just three years. But the recoat may hold up for eight to 10 years, according to USDA Forest Products Laboratory tests.

Stains are made in a wide variety of colors that look good on almost any home, from ultramodern to old Cape Cod. They are at their best when applied to bare wood, but they perform well even when you put them on over existing paint.

On top of all this, a good stain will run about three dollars less per gallon than a good paint. And if you ever decide you'd rather paint your house than stain it, no problem. You can put paint on over stain. The only limitation is that creosote stains must weather for two years before they become compatible with paint top coats.

Stains may be easier to keep in top shape than paints, but they can be a lot harder to buy—simply because there are so many different kinds. They run the gamut from the old, reliable, oil-base penetrating stains to those modern latex formulas.

Still, stains break down into two main types: semi-transparent stains and opaque stains, which are really more like paints than true stains. Your first step in selecting a stain is to choose between these two main types. Here are some general rules to help you choose:

Semi-transparent stains

These stains penetrate the wood and dye the fibers. They contain very little pigment, so they let the grain of the wood show through.

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Redwood's natural color enhances the striking contemporary home at left; Olympic's Natural-tone stain helps maintain the wood's good looks. It's a transparent stain, based on linseed oil. Beautiful, trouble-free protection for the home below comes in the form of two coats of Glidden Spred transparent "White Birch" exterior stain.

This makes them the stains to use when you want to enhance or emphasize the natural beauty of good wood. They are also your best choice for decks, patios, and outdoor furniture: Since they penetrate the wood, they won't wear off on shoes or clothing.

On the other hand, a semi-transparent stain is a poor choice for low-grade woods, wood that has weathered unevenly, or wood with defects you'd like to hide. Don't use it over wood that's been previously painted, wood that has been stained with an opaque stain, or on any other sealed or nonporous surface. You *can* use it over other *semi-transparent* stains, as long as those stains are of the same tone or lighter than the new stain.

Masonry and concrete? Some semi-transparents do very well over these materials, and others do not. Check the instructions on the label to be sure.

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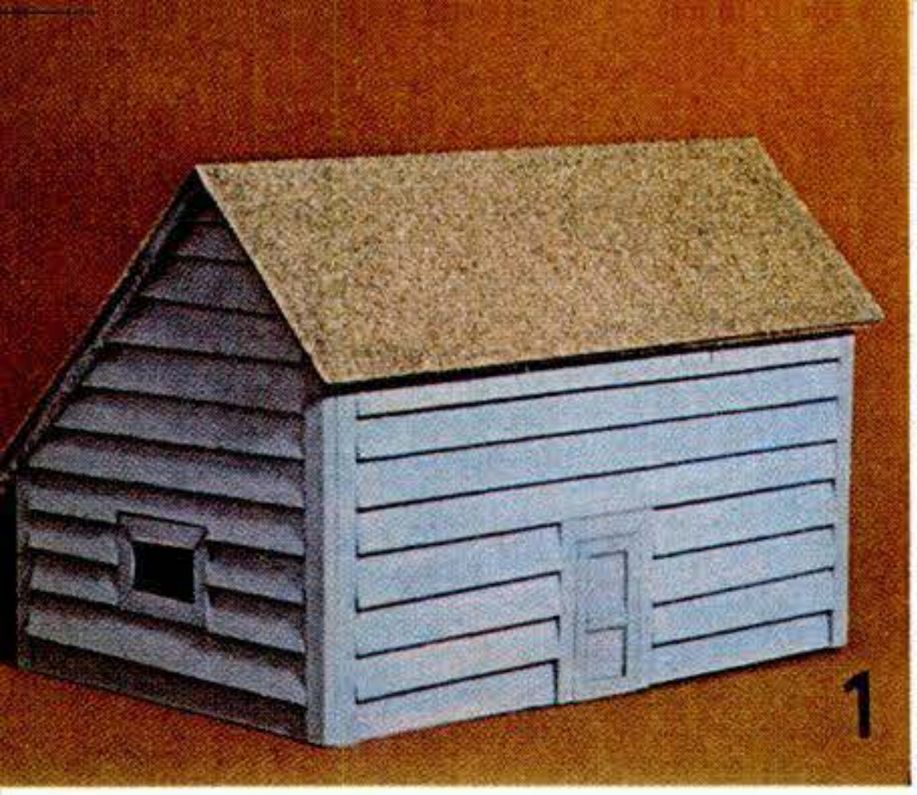

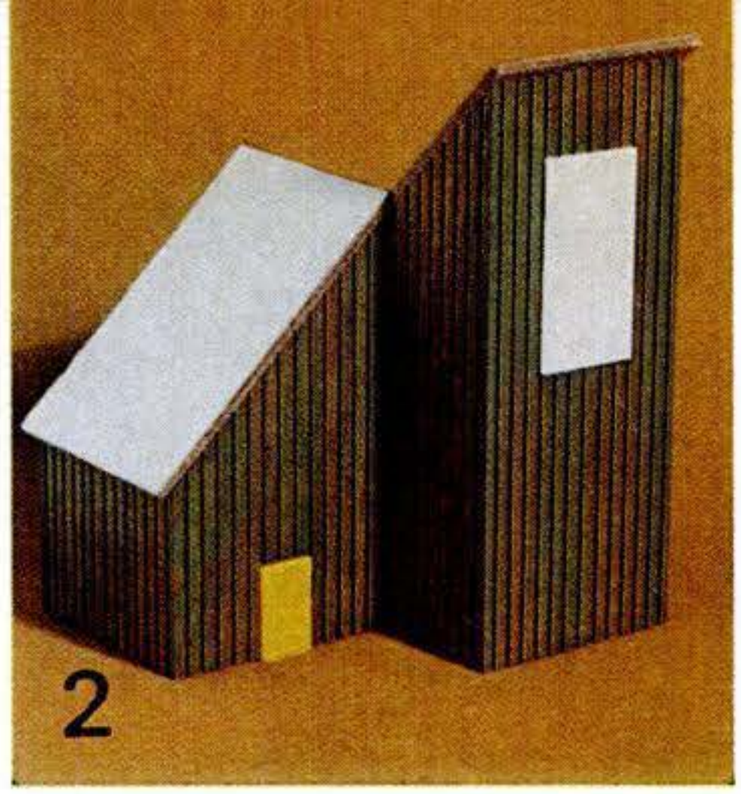

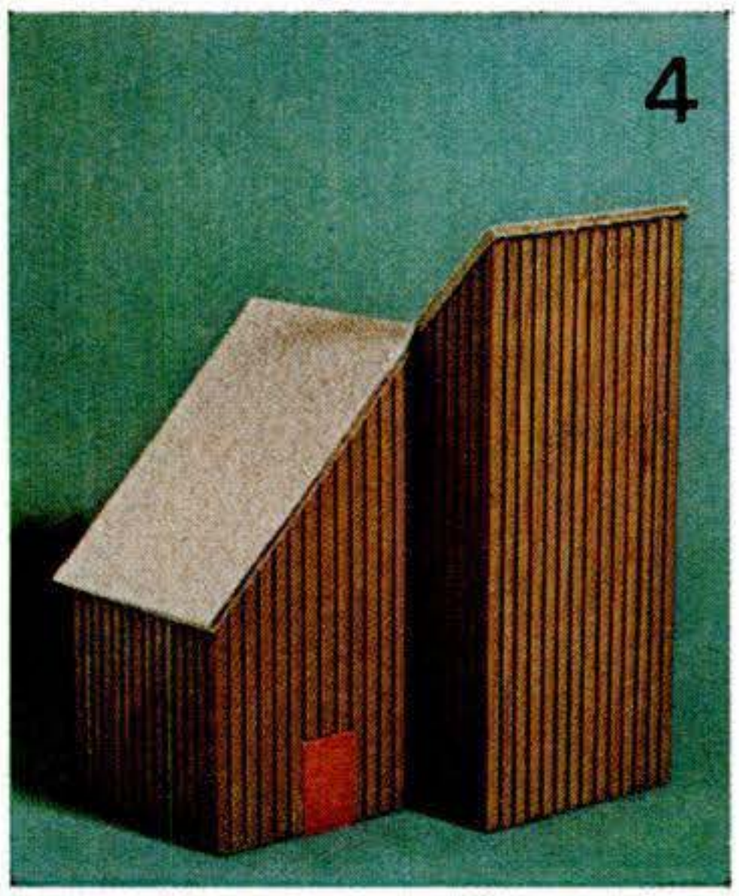

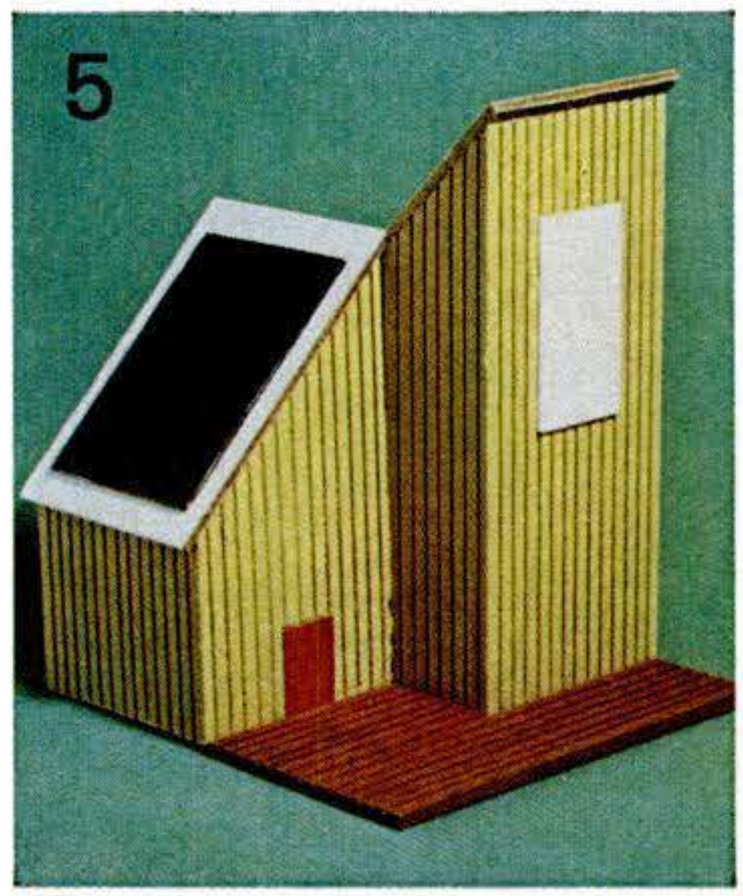

1: New England salt box stained with Cuprinol "Seashell" semi-transparent stain has the look of naturally weathered cedar clapboards. **2:** Semi-transparent "Sherwood Green" by Sherwin-Williams lets the grain and texture of the wood show through while it protects against the weather. **3:** Semi-transparent "Redwood" is a linseed-oil-based stain by Olympic that gives most common construction lumber the look of natural redwood. **4:** Alkyd-type semi-transparent stain gives wood good protection and long life. This is "Rustic Brown" Moorwood stain made by Benjamin Moore. **5:** Opaque "Harvest Gold" stain by Olympic is good for siding, but a semi-transparent stain is better for decks since it won't rub off on your shoes. **6:** Natural color of fresh wood can be maintained with clear stains, or you can get a natural, weathered silver gray with special bleaching stains.

Opaque stains

Use these stains when you have something to hide. Their opaque film of color will cover blemishes, uneven weathering, rust stains, unattractive grain, and other defects, just as a coat of paint would. Opaque stains, however, produce a thinner film than paints, so surface textures are still visible.

Opaque stains are a good choice for homes built of dissimilar woods; they cover the differences in color between, say, cedar siding and pine trim. Semi-transparent stains will not do that.

Opaques are also best for trim. You can use them in combination with a semi-transparent stain if you wish. Use the semi-transparent on siding, and an opaque stain—in the same color or a contrasting tone—on trim.

Most opaque stains can be applied over sound paint. That sounds like heresy if you think of exterior stains in the same terms as interior stains. But the two have little in common. To quote the USDA's Wood Handbook: "Opaque stains are really considered to be more like paint because of their film-forming characteristics."

According to Glidden's James Sainsbury, the main difference between an opaque stain and a paint is "the amount of total solids (pigment plus film formers) by volume." Stains contain less solids and more volatiles. So when you cover paint with an opaque stain, you are essentially covering it with diluted paint, and there's nothing heretical about that.

Most opaque stains can be used over nonporous surfaces such as metal downspouts and gutters. And finally, the newest type of opaque stain—acrylic latex—has quickly earned a reputation as the most durable, long-lasting stain available.

In many applications, both semi-transparent and opaque stains are equally suited to the job. In that case, pick the type that looks best to you. If you can't decide, start with a coat of semi-transparent stain. If you don't like the result, you can go over it with a coat of opaque. Meanwhile, the semi-transparent stain will soak into the wood and provide a sort of prime coat.

Which formula?

Deciding between opaque and semi-transparent stains is only half the battle. Next you'll be faced with a variety of different formulas to choose from. Semi-transparent stains may be based on linseed oil, mineral spirits, creosote, alkyd resins, even water. Some contain wood preservatives and others do not.

Which is best? It's a matter of trade-offs. Oil-based stains are often available in the widest selection of colors. But linseed oil is more vulnerable to mildew attack than other

[Continued on page 124]

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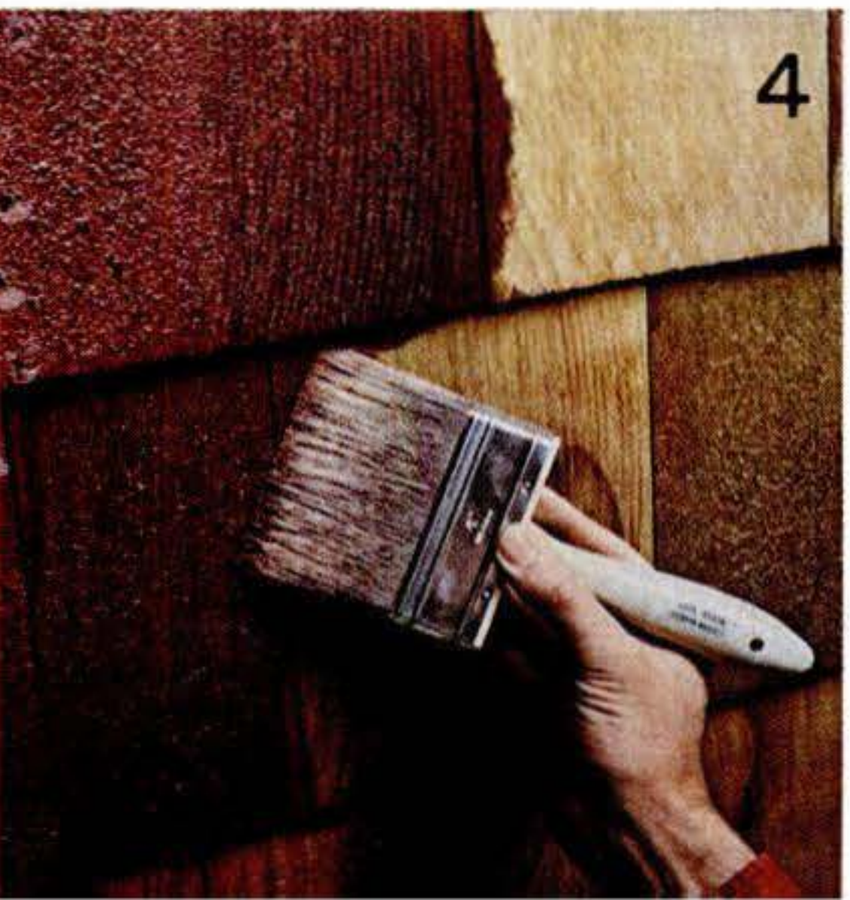
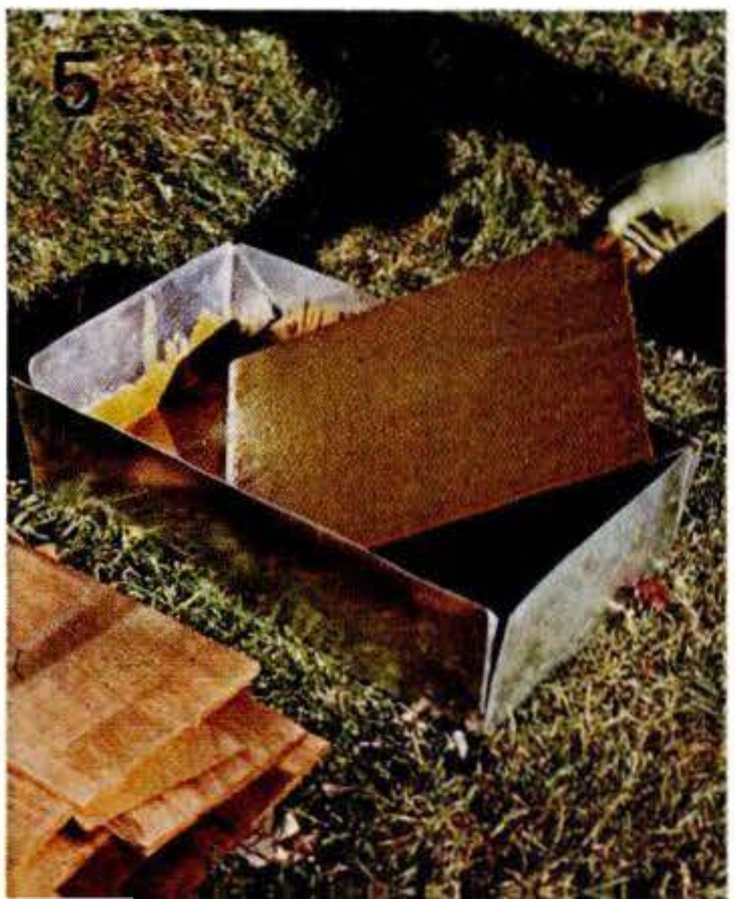
Wood sample chips at left give a good idea of the colors of stains available. First, however, you should test stain on a wood scrap or an inconspicuous part of your house.





1: Pad applicators work well on smooth surfaces. Here, an opaque stain is going on over paint. Note how the texture of the grain shows through the stain. **2**: Spraying is the fastest way to apply stain. **3**: For best penetration, while the sprayed stain is still wet go back over it with a backbrush—a carpet scrap fastened to a block of wood on a broom handle. **4**: Brushing is the best all-around way to apply stain. This stain brush has short bristles that work the stain into cracks and crevices. **5**: Dipping is a great way to protect both sides of cedar shingles, but not all stains are suitable for dipping. Check label instructions.

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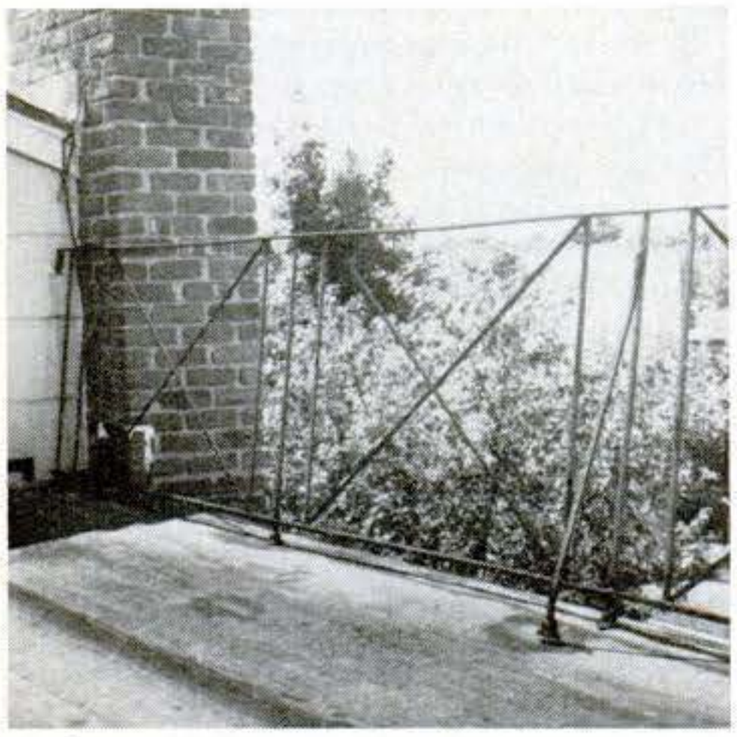
IMPROVE YOUR HOME

Three simple steps to a lively sun deck

Add a grass carpet, a striking railing, and a clever planter

By ROSARIO CAPOTOSTO



Before renovation, this bleak sun deck had a flimsy railing and an ugly floor.

An upper-story sun deck offers a quiet, private place to sunbathe, dine outdoors, or just escape from household chores. Yet many homeowners neglect their sun deck because of its raw, uninviting appearance.

A typical sun deck has an unsightly tar-paper floor that you don't dare walk across on hot days for fear of tracking melted tar indoors. The railing is usually flimsy and unsafe, barely capable of holding itself up, let alone people.

But an attractive transformation is relatively easy—and needn't be expensive. To give your deck some eye appeal, lay a plush, grass-like outdoor carpeting and install a strong, good-looking railing. Then top off the railing with a unique, continuous "flower pot" (made from gleaming white aluminum rain gutter) filled with small flowering plants.

"Great Outdoors," the artificial grass carpeting I used, is an Armstrong product that's made to withstand exposure to sun, weather, and traffic.

Prepare for installation by removing the old railing and sweeping the floor clean of dirt and debris. Then patch up any holes or loose seams with a roofing compound.

Installing the carpet is fairly simple, especially if no seams are required (see photo). If you need seams, cut the pieces and fit together before applying adhesive. Be sure to lay each section with the nap running in the same direction. The pieces should be tight enough to form a slight peak at the joint. If the carpet edges aren't straight enough to make even seams, snap a chalk line on the back about 1½" from the edges and trim.

After fitting the pieces together, fold back the carpeting on each side of the seam and spread about a four-foot-wide patch of adhesive

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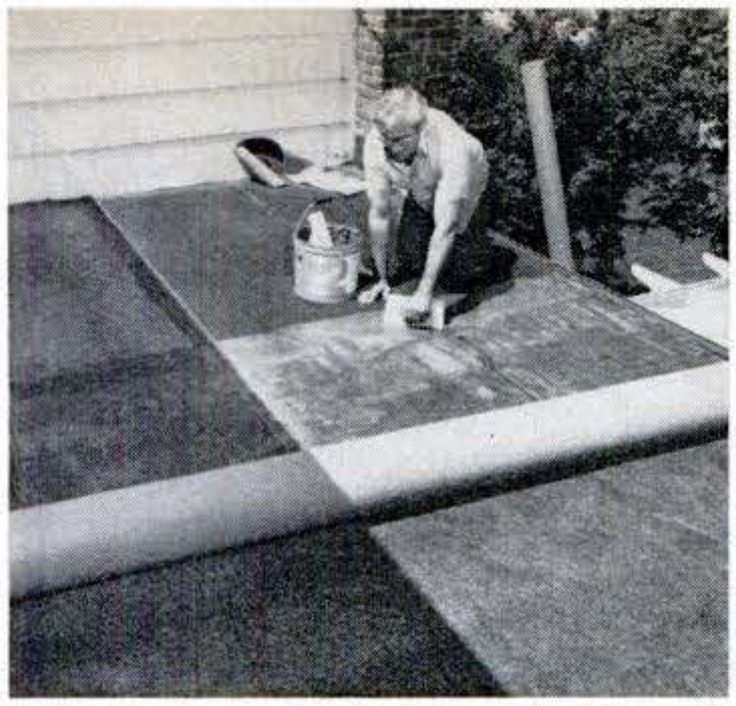
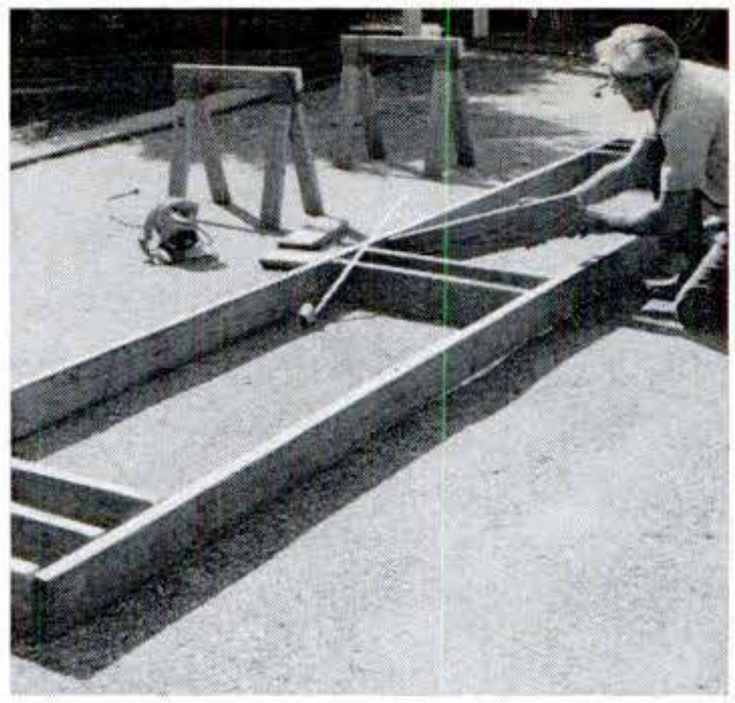
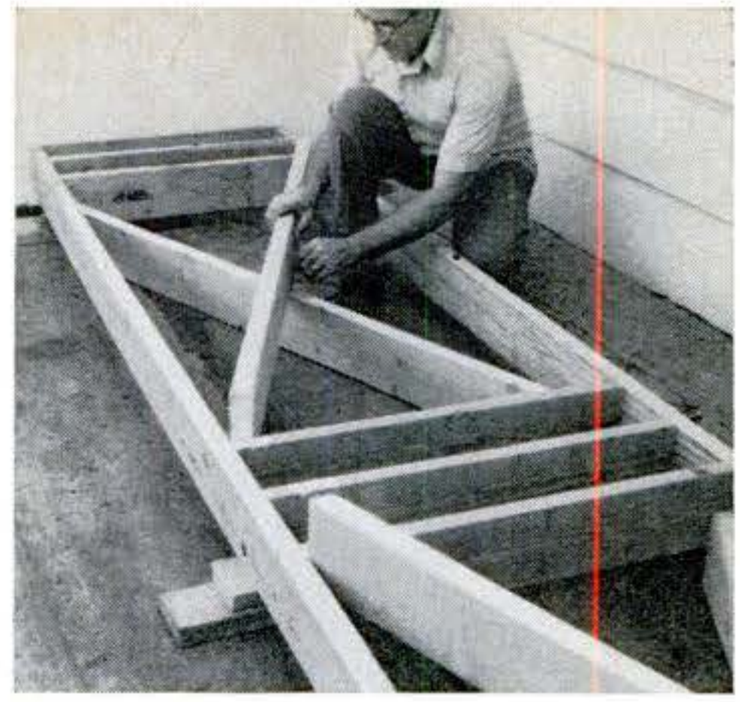


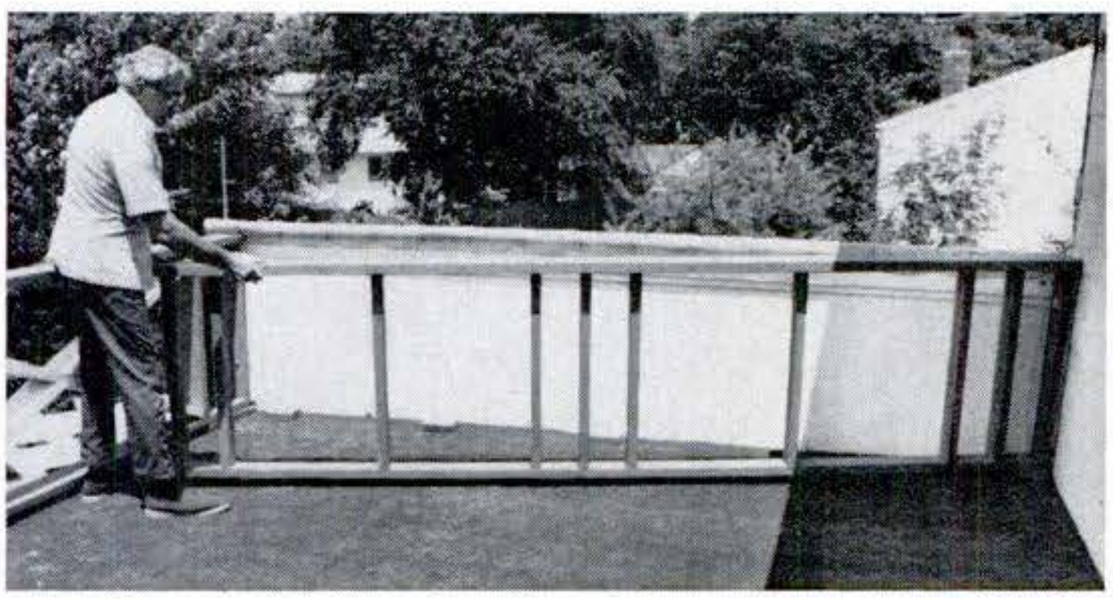
Cut the carpet to fit the area, then re-roll it onto the tube for easier handling. With a notched spreader apply carpet adhesive to about one-half the deck floor. When the adhesive is tacky, roll the carpet onto it, leaving a few inches of adhesive exposed so the next application will overlap



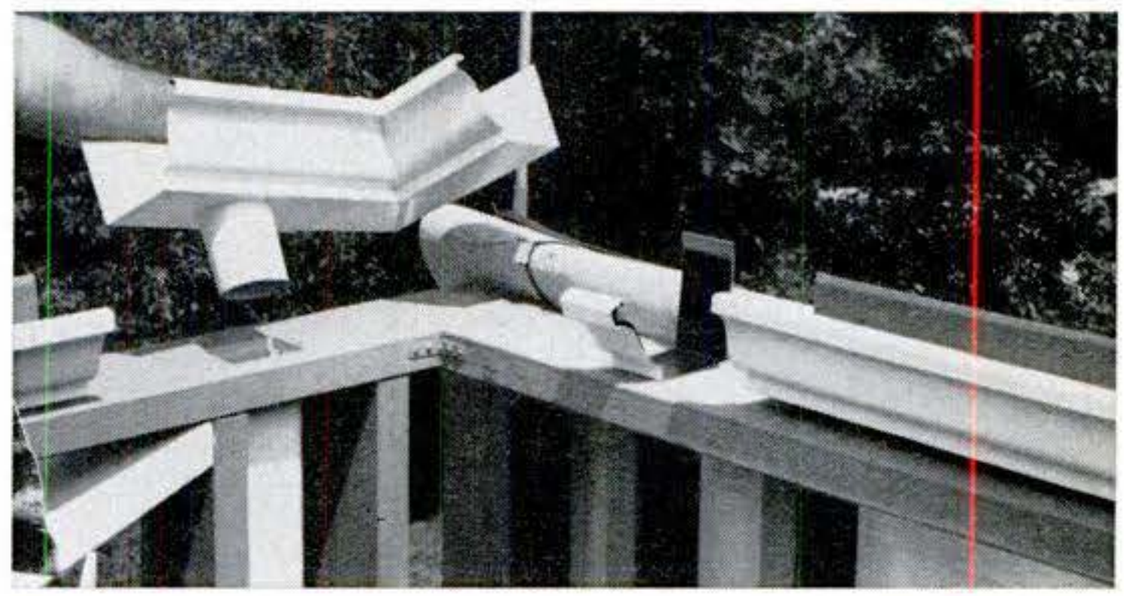
Assemble the basic railing by using hot-dipped galvanized nails to join the verticals to the top and bottom. Next, rest a diagonal in place on the assembled rail and trace directly from the frame to mark the ends for cutting. Make the beveled cuts with a portable circular saw, guided with a wood strip.



After cutting one diagonal, insert it in the frame and hold the second one in place. Mark both the ends and the intersection. Cut the cross-lap joint with a saber saw, using a coarse-set tooth blade. Set the saw to the needed angle and make two parallel cuts in board. Knock out waste with a chisel blow.



Set the railings on blocks, then check their pitch with a level. They should slope slightly toward a common low spot so the planter has proper drainage. To get the right pitch (1½" per 20'), insert shims below the floor blocks, then nail the railings in place. Next, bore pilot holes at a slight inward angle through the verticals and attach the diagonals with 3½" hot-dipped galvanized nails. Paint the railing with a non-water-based paint before adding the gutter planter.



To provide drainage for the gutter planter, use an inside corner section with a drop outlet. Insert this into a downspout through a hole cut in the top of the rail. (The downspout drains into the existing gutter at the edge of the deck.) Join the planter sections with snap-in connectors (one is shown sitting on top of the right rail) and caulk all joints to make them watertight. Then use rustproof screws to attach the assembled planter to the top of the railing.

down the center of the floor. Wait for the adhesive to tack up (form strings under finger pressure), then fold one side of the carpet back into the adhesive. Fold back the second side and butt it against the first to form a tight seam. Then cement down the rest of each section. Finally, use a rolling pin to smooth out any air bubbles, working from the center out to the edges.

If you lay the carpet on a very hot day, the adhesive will tack up quickly, so you should work on smaller sections at a time—even if you're laying a seamless piece.

Raising the railing

For the sturdy main railing I used 2x6 lumber throughout. For the side railing, which backs up against the parapet wall, I used 2x4's, except for the top, which is a length of 2x6 lumber. I added this railing mainly to extend the design of bold verticals across an otherwise plain background. It also supports part of the planter.

I used Wolmanized pressure-treated lumber [PS, April '76] for all members. If you use ordinary lumber, be sure to apply a wood preservative.

Assemble the rail sections offsite so you can do direct face-nailing for a neat, strong job. The diagonally crossed members, however, can be attached after the rail is in place since face-nailing is feasible through the uprights. But measure and cut these members to fit before you install the railing (see photo). The ends of these cross members must be bevel-cut so they rest against the sides of the verticals. The diagonals are joined edgewise with an angled cross-lap joint. After cutting these joints, check for fit. Each notch should be just a hair wider than the board that will fit into it.

To install the railings, set them on a few 1½" blocks to allow for air circulation and water runoff. Avoid anchoring the rail into part of the deck that's not supported by a beam. This might cause an eventual roof leak. Instead, drive galvanized lag screws through the ends into a vertical member of the house.

Preparing the planter

I used baked-enamel aluminum guttering for the planter. If you have an L-shaped railing, you'll need a left and a right end cap, 10-foot lengths of gutter to fit, a drop outlet with elbows, a downspout, an inside corner, and snap section connectors. These solderless fittings make assembly quite easy (see photo).

Finally, fill the completed planter with topsoil over a half-inch layer of gravel for drainage. Now sow seeds in the planter, move in the outdoor furniture, and enjoy your renovated sundeck. PS

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Staggered-joint pattern gives Housers' ceramic-tile floor two different looks, depending on viewpoint (compare top and bottom photos). Tile layout starts at short wall (with blue arrow), continues into laundry and bath (left center). All materials used (from all manufacturers) are sold at American Olean stores; for addresses, write company (Lansdale, Pa. 19446).

Tile-setting patterns

change the look, ease problem installations

By DAVE HOUSER and V. ELAINE SMAY

The standard way of laying ceramic-tile floors—in a straight grid pattern, like oversize graph paper—may not be the best for every room. A long, narrow room, for example, can be made to look wider if the tile is laid in a diagonal pattern. Two different colors of tile can help to pull together a room's color scheme. Two or more sizes of tile can add variety to a "plain-box" room. A herringbone, basketweave, or pinwheel pattern—or one of the others illustrated on these pages—can enhance and individualize any floor.

When PS art editor Dave Houser and his wife Rita decided to tile their basement recreation room, they chose a staggered-joint pattern. It offered many advantages:

- It gives a different look to the floor from different viewpoints.
- It makes the room look less tunnel-like, since the staggered lines run the length of the room and the parallel lines, the width.
- It allowed a less noticeable grout-line compensation for a slightly out-of-square wall, avoiding the use of awkward tile fragments along the baseboard.

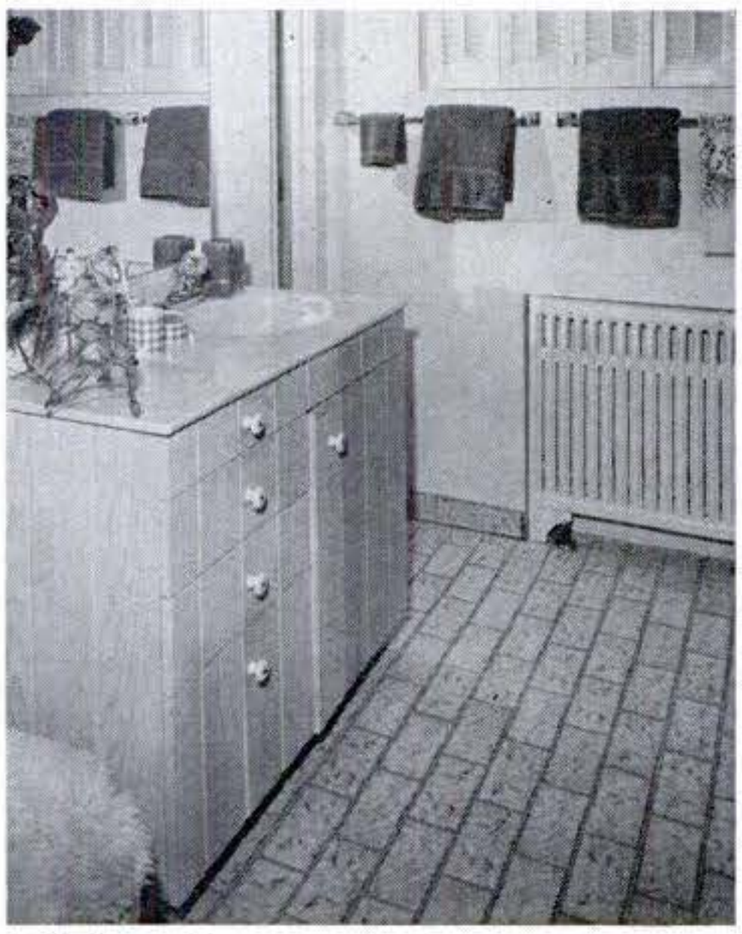
Usually you begin a tile layout by snapping perpendicular chalk lines that bisect the room in both directions, then moving either or both lines a little to minimize cutting along baseboards. But the Housers' room is full of nooks and crannies, so Dave started his layout at the most noticeable wall—a short partition at the foot of the stairs. Other measurements indicated that this start would work well for the entire room.

"Because the materials are intended mainly for professional tile layers, the directions on labels tend to be a bit sketchy," reports Dave. He offers these tips to make your job go smoothly:

- "Planning and measuring are the keys to success. Draw your proposed tile layouts to scale on tracing paper or acetate and use them as overlays on your floor plan, drawn to the same scale (see photo). It will help you determine where to begin your layout as well as what pattern to use.
- "Remember to consider the spaces between tiles when planning your layout.

Continued

One tile size, three different looks



All three floors in the photos above use 4"-by-8" ceramic tiles, but see how different they look. Staggered-joint pattern (left) adds length to a small bath. Simple basketweave (center) uses a single color of tile to achieve subtle and sophisticated floor. Basketweave, within squares formed by darker tiles, gives real pizzazz to kitchen at right.

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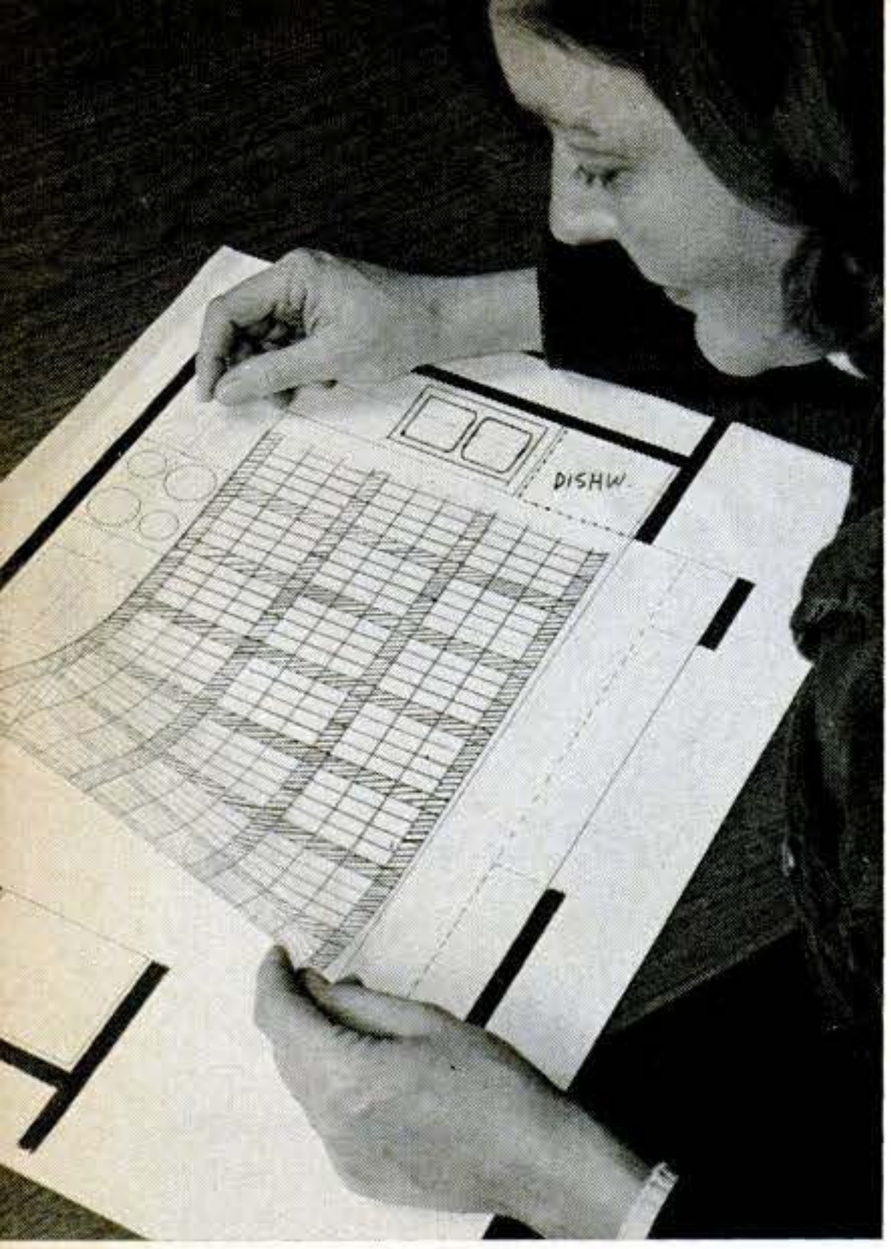
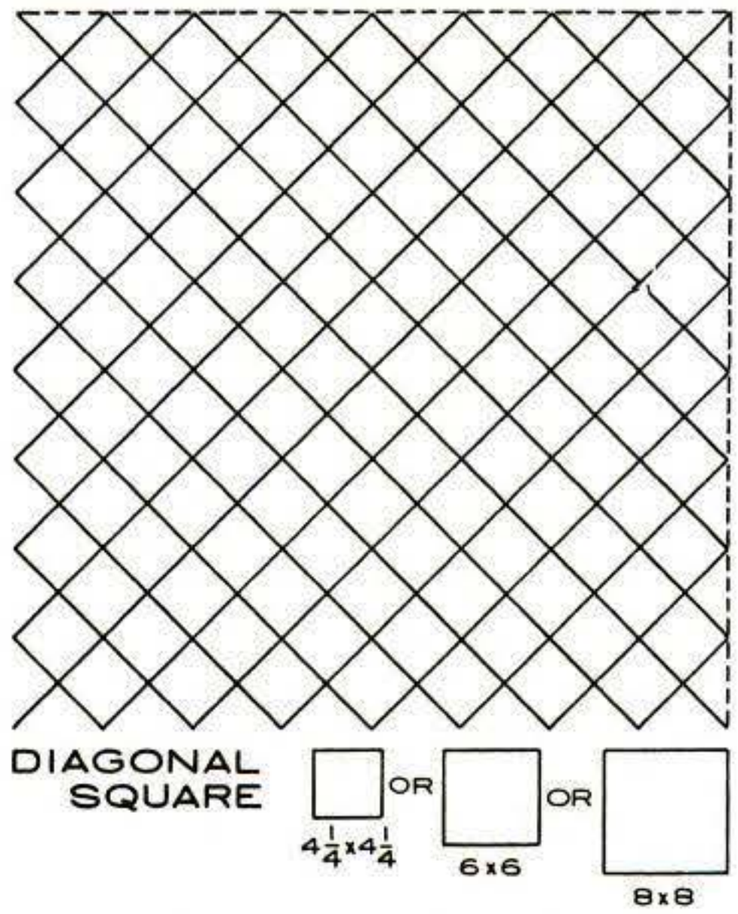
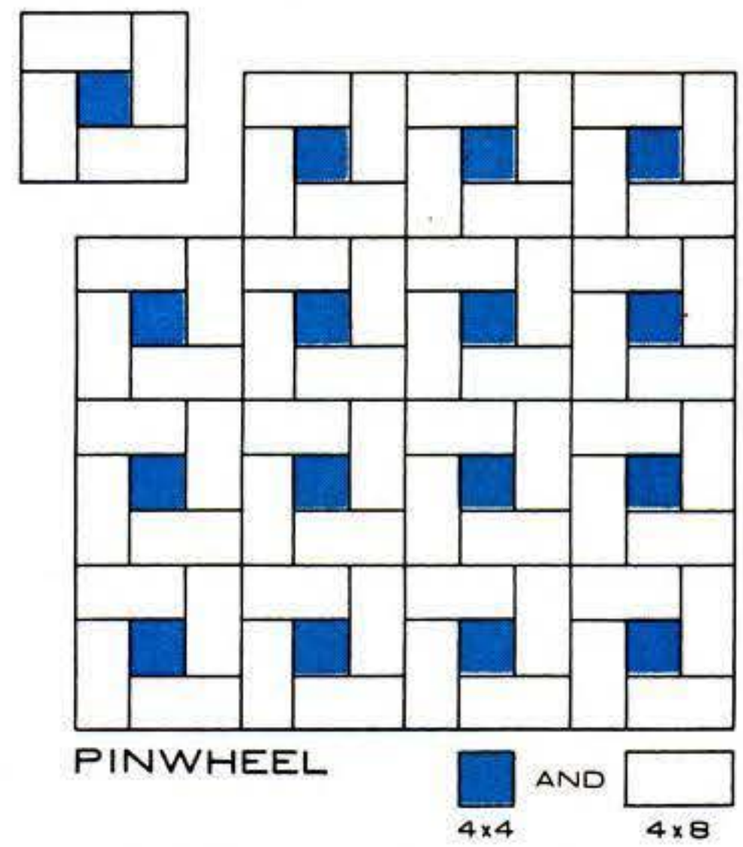
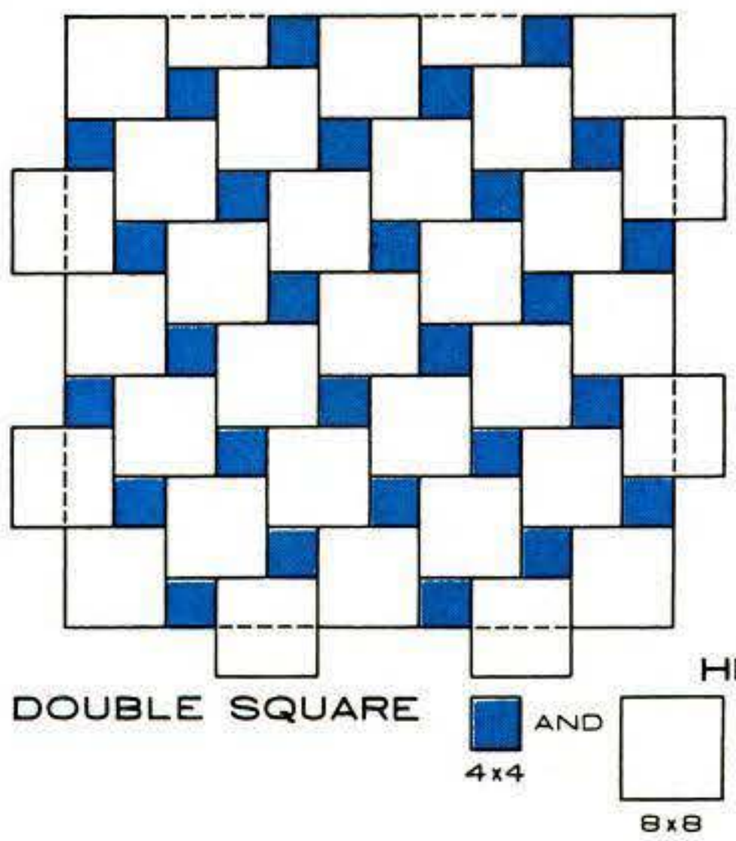
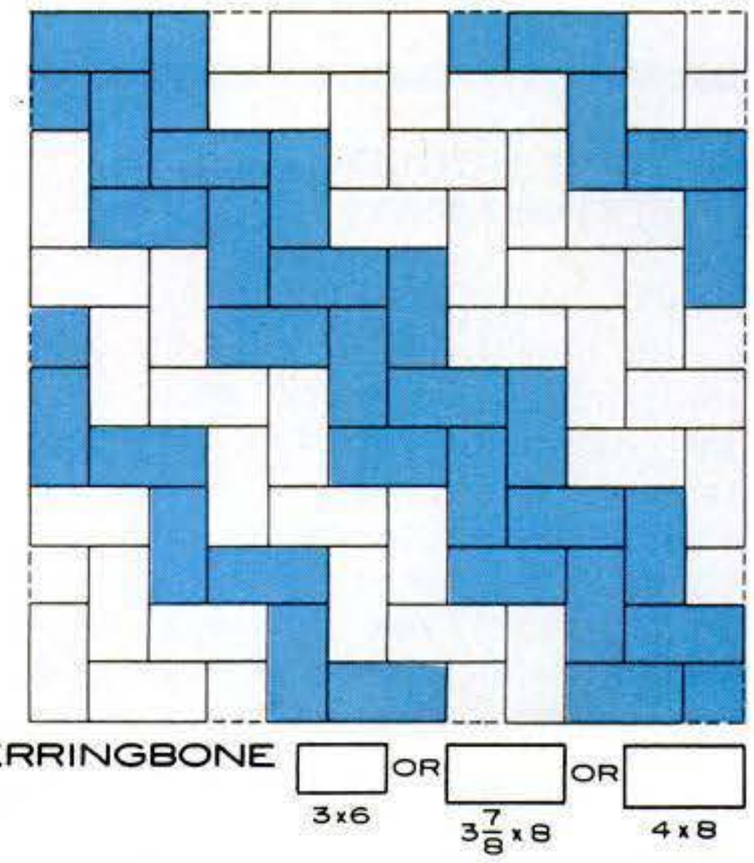


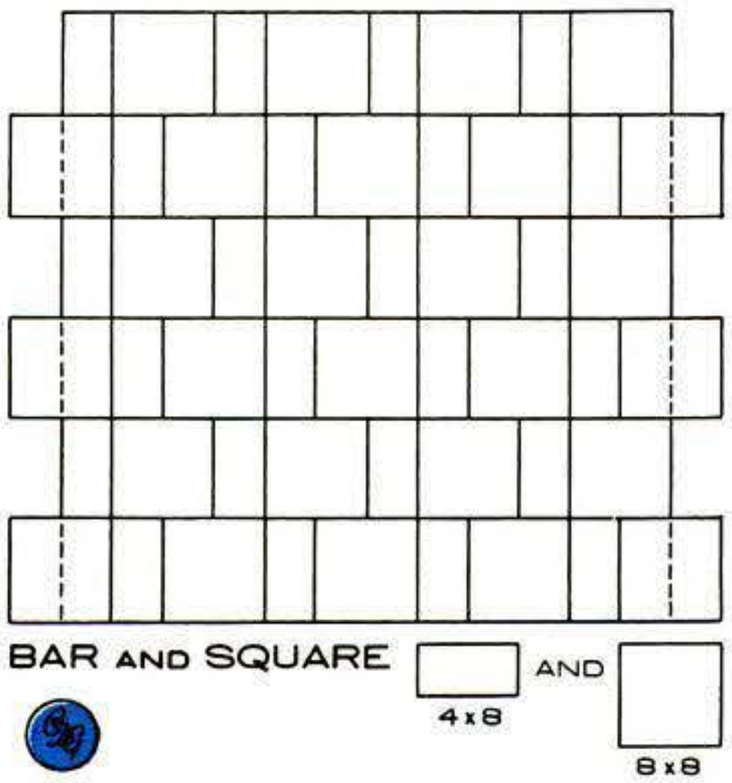
Some imaginative patterns for ceramic tile

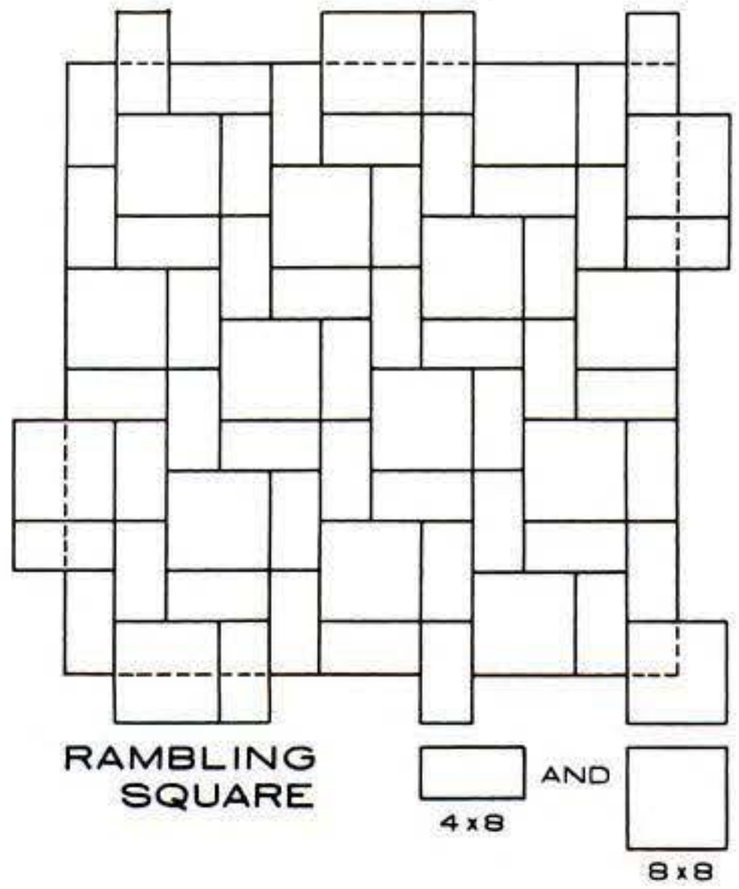












Try patterns on acetate or tracing-paper overlay in same scale as floorplan. Note how pattern was adapted to kitchen in photo. Diagrams at right are samples from pattern booklet; send $2 to American Olean, Lansdale, Pa. 19446.

• "Remove all baseboard moldings and include the space under the moldings when ordering the tile and planning the layout.

• "If your room is slightly out of square, pick your longest wall as your starting point (assuming it's straight). Make your compensations on shorter walls. Also, such flaws will be less noticeable if you choose a pattern that doesn't have all long, continuous joints—the curse of the grid pattern.

• "If the room is badly off-square, consider remedying that problem first, perhaps with thicker baseboard molding or perimeter seating and storage.

• "Keeping even spaces between tiles is essential on long, straight grout lines (less so on the staggered ones). My ⅜″ plywood spacers were 5″ long (see photo 2). I tried one 4′ long but found that it gave a little, making a wavy joint that I had to correct.

• "The job I tackled—about 450 sq. ft.—was pretty ambitious for a first project. I'd recommend that you do a foyer, bathroom, or small kitchen first. Ceramic-tile laying is not difficult or tricky, but is time-consuming and strenuous."

In the photos and captions on the following page, Dave takes you through his installation. PS

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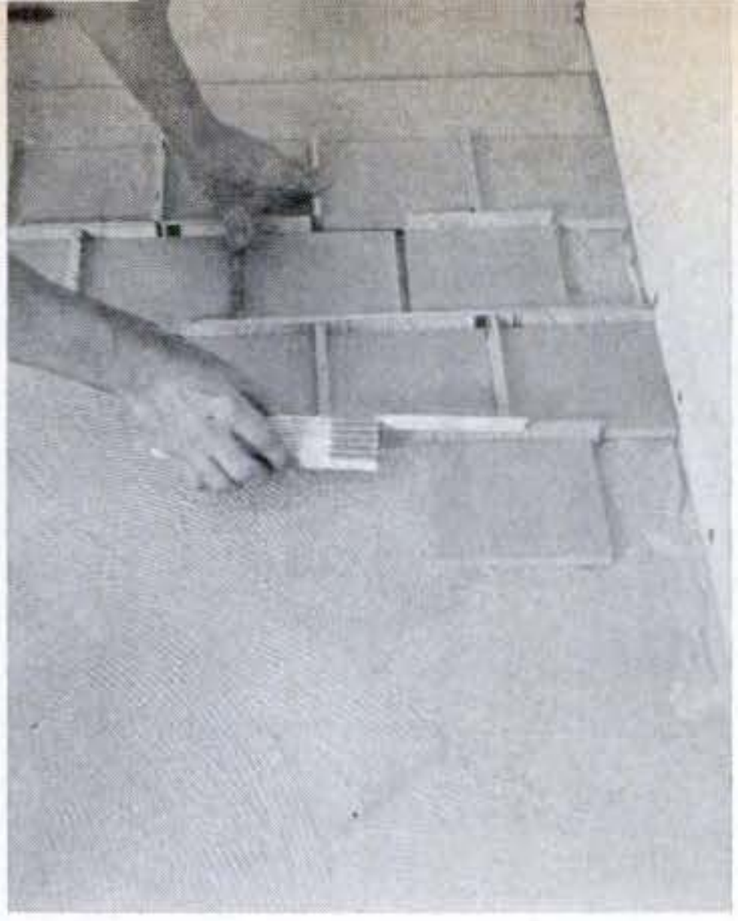
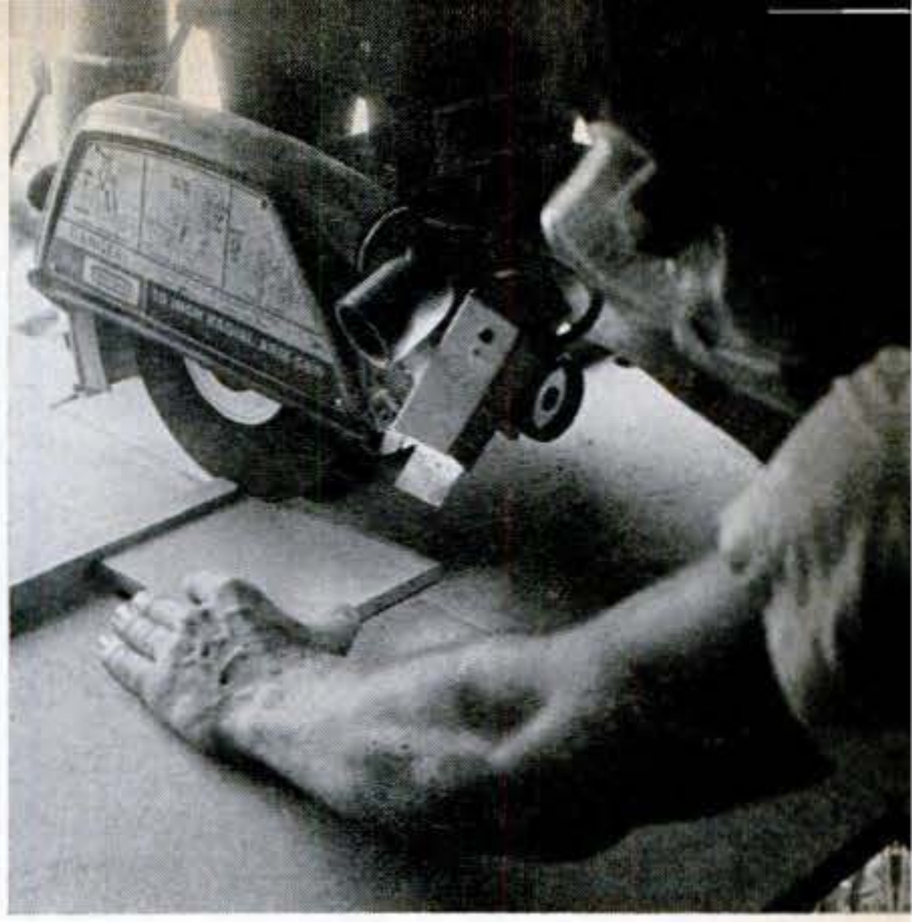
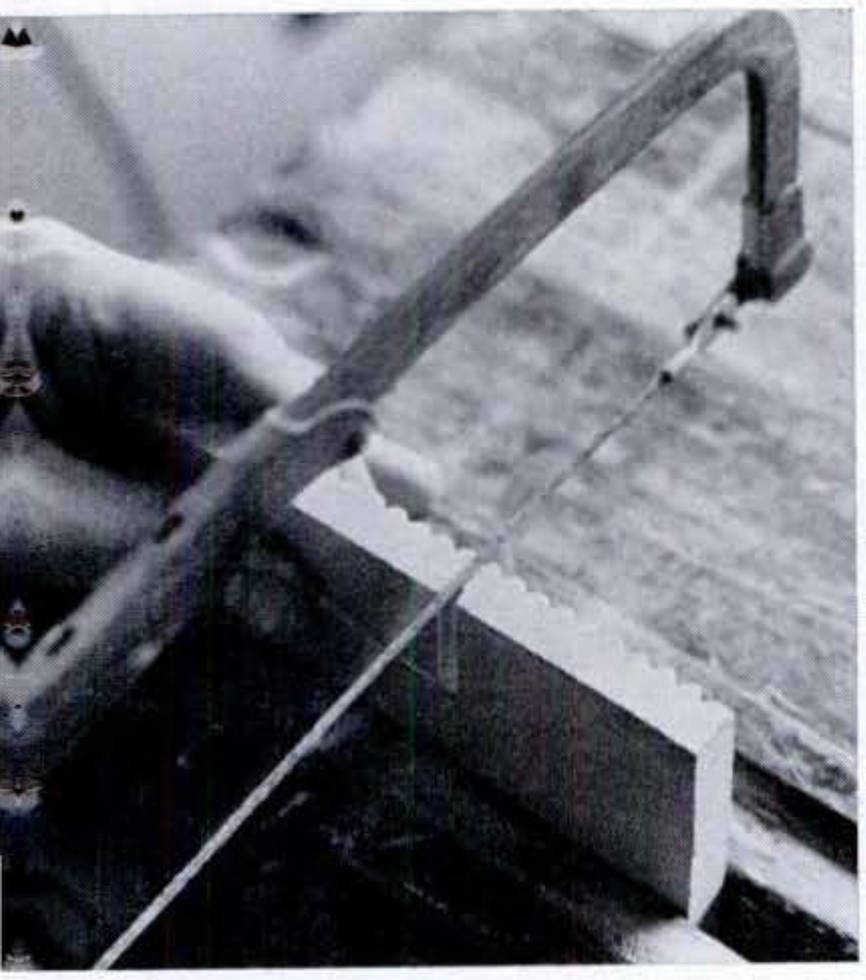
1 Materials: I [author Houser] used 6"-by-6" Golden Glow quarry tiles, ceramic-floor-tile adhesive (both from American Olean), and dark brown Acid-R portland cement grout by L&M Surco.



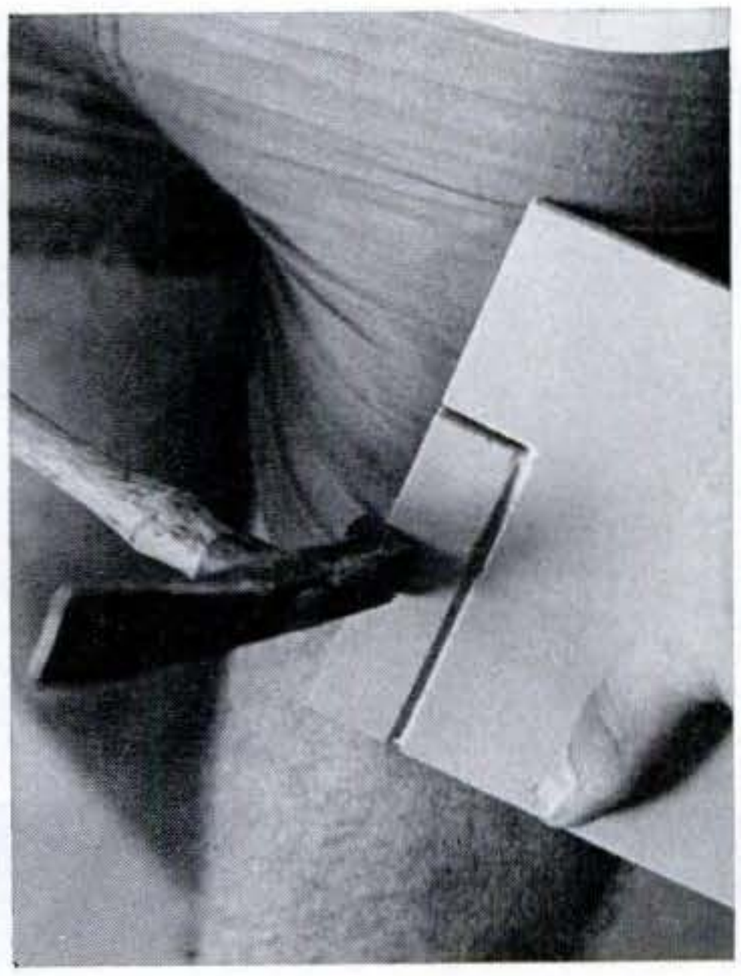
2 Installation began on most noticeable wall (see text). Full- and half-size tiles abut wall. For spacers I used 3/8" ply since my tiles had no spacer lugs. Notched trowel (1/4") spreads adhesive.



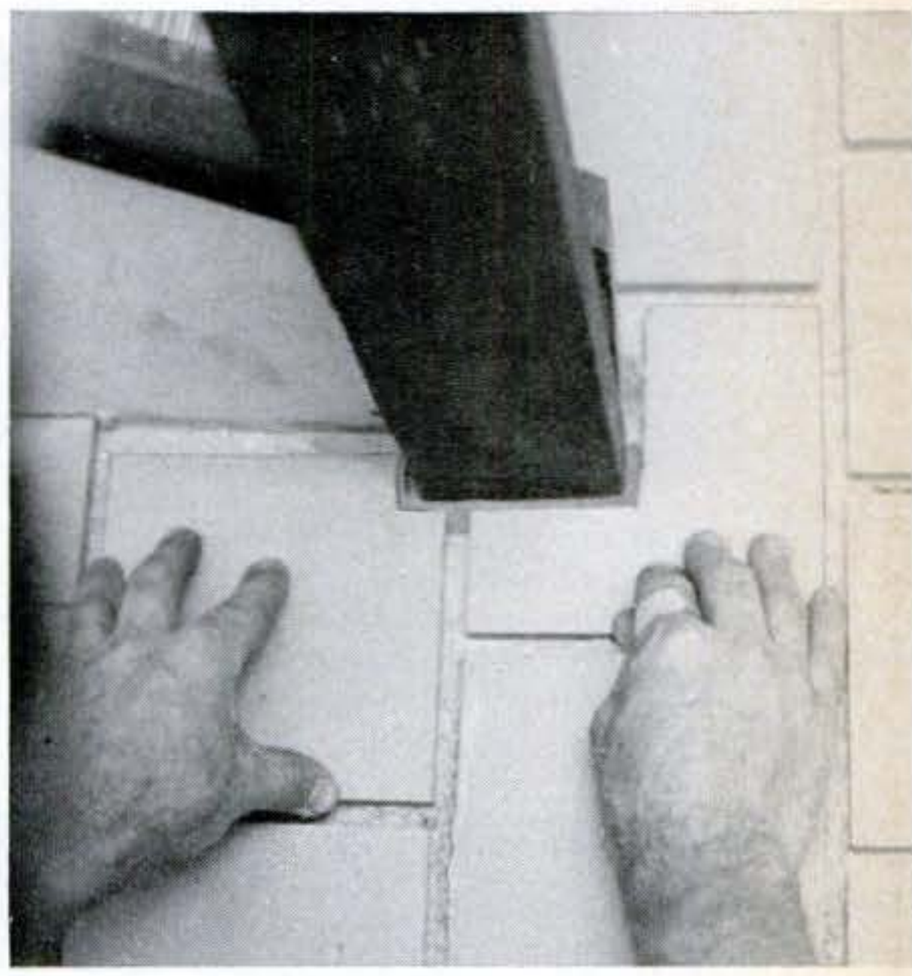
3 To notch tile, I scored top with masonry blade in my radial-arm saw. Stopping cuts at corner of notch prevents circular blade from cutting through. Dust is fine, so wear mask and goggles.



4 I finished shorter cut of notch with Remington's Grit-Edge blade in hacksaw. Note that radial-blade scoring provides good starter nick. Keep saw perpendicular to tile and saw to corner of notch.

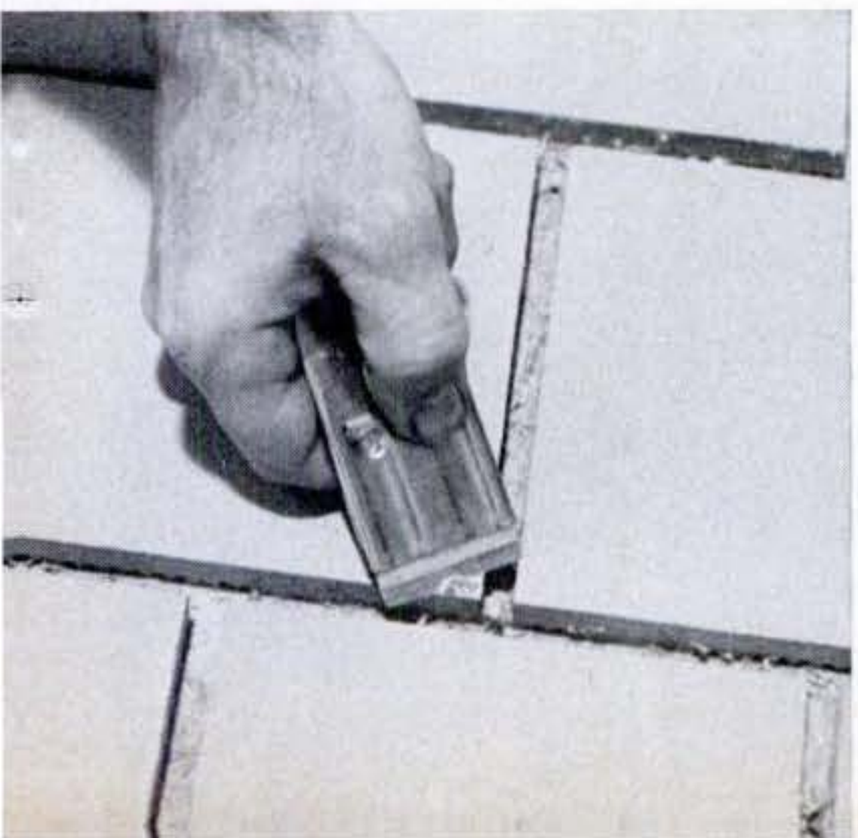


5 To remove the unwanted part, I placed the scored and cut tile section against my thigh and rapped it with a hammer. It's tricky—and hard on thighs—but much faster than making long cuts.



6 These two tiles were cut in manner just shown to fit around newel post. Space from tile to any obstruction should be same width as grout space between tiles (3/8" in my case).

7 I scraped adhesive from tile tops and edges with razor. Then, to make grout cleanup easier, I sealed tiles with Lok-Gard II (from Hillyard). Prewaxed tiles would eliminate this step.



8 I mixed grout in large bucket, using a bit more water than called for to make spreading easier. A rubber trowel is used for spreading grout—at a diagonal to tiles. Consider knee pads essential!

9 I wiped tile surface at 45-deg. angle with clean wet rags, then mopped with Super Shine-All (Hillyard). Muriatic acid removed remaining grout. Final sealing with Lok-Gard II finished job.

Sleek metal home (with detached garage) is an unexpected sight in heavy woods. Though all structural framing and t&g siding and roof panels are metal, wood is used for the generous deck and in the student-designed, built-in kitchen counter and L-shaped couch (below). Note how clearstory windows flood angled ceiling with light.

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All-metal house
goes up like an erector set

Hard to believe this elegant two-bedroom cottage is assembled from bolt-together industrial components? Here's how you erect it

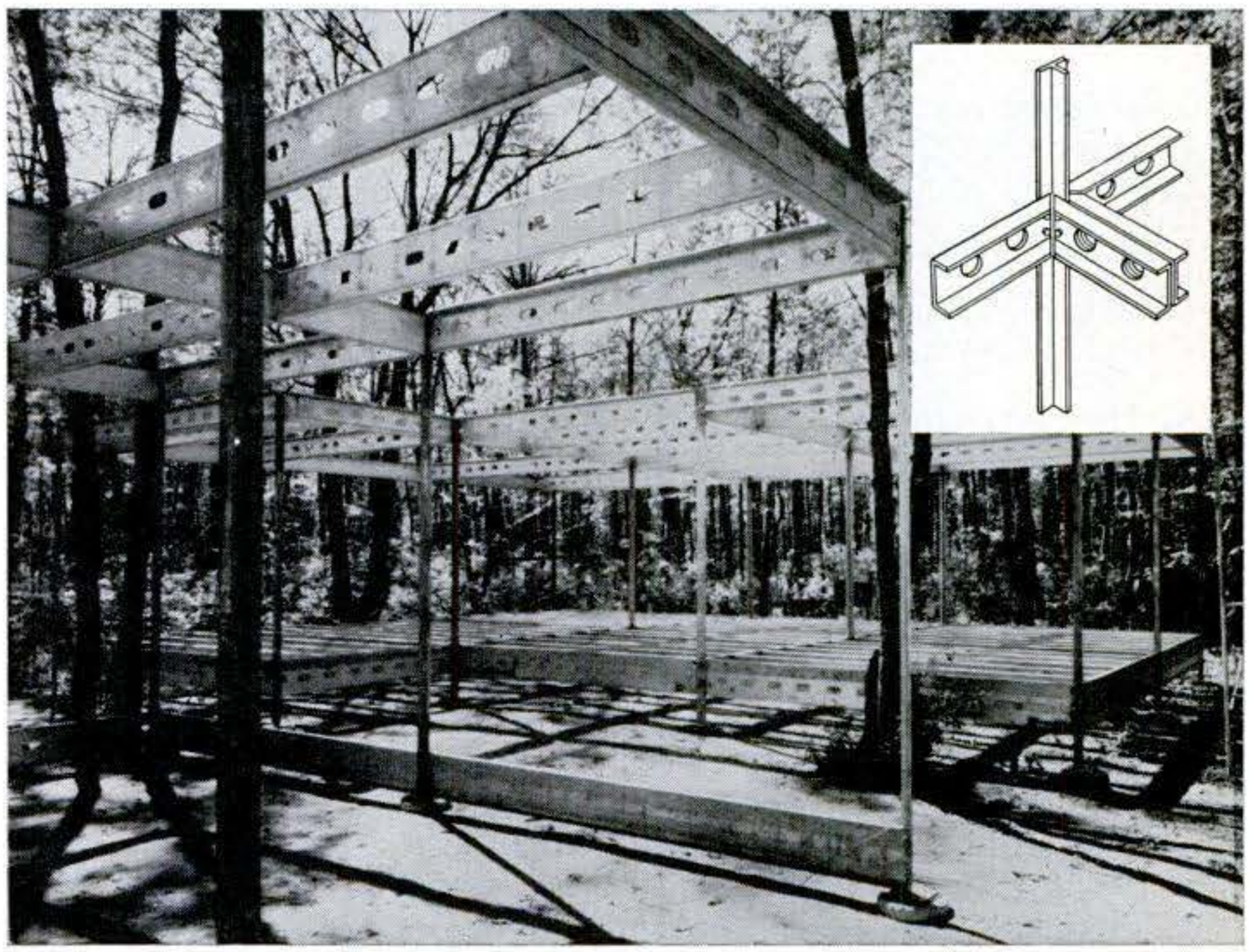
By AL LEES

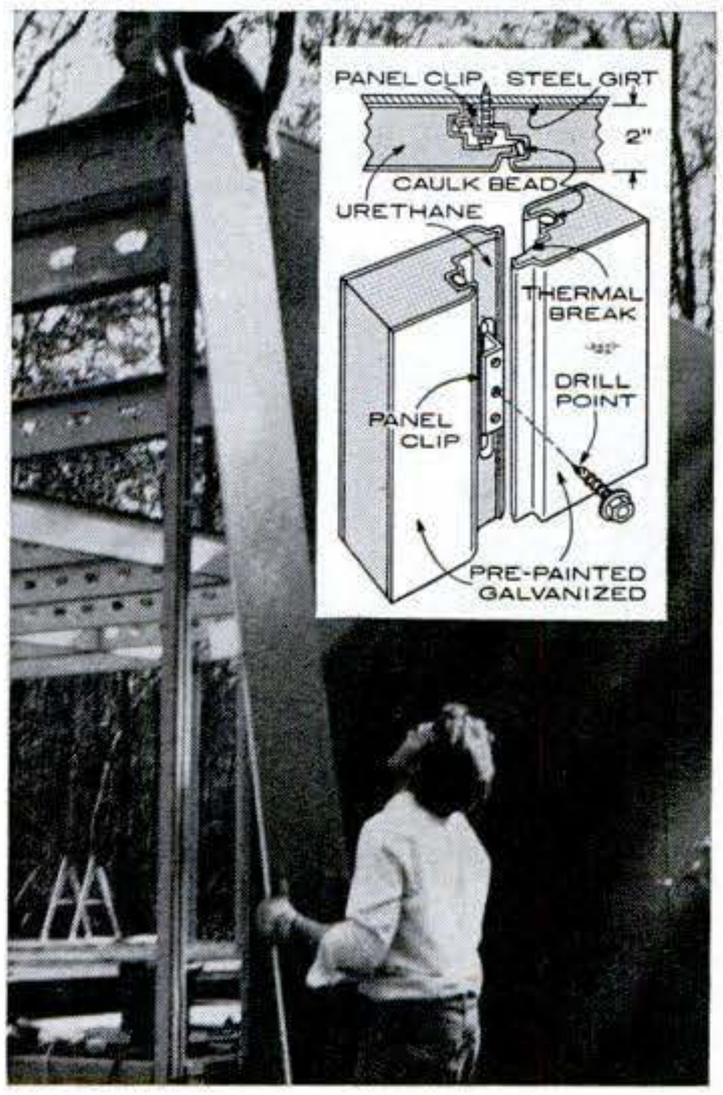
PROVIDENCE, R.I.

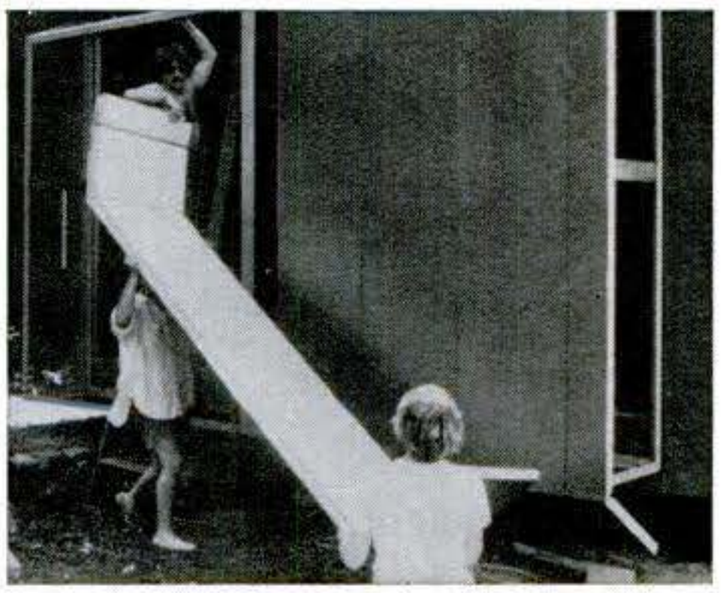
I've just toured what might well be the house of the future, though it's assembled from components manufactured today for commercial structures such as industrial plants. My guide has been professor Marc Harrison, chairman of the industrial design program at Rhode Island School of Design (RISD). With three dozen of his students, Harrison worked for five years on this project, which was sponsored by the International Lead Zinc Research Organization (ILZRO). The design team then erected the house on a remote wooded site outside town, and Harrison moved in with his family to test the structure's livability through the severe '76-'77 winter.

Although as project architect Harrison might be a bit prejudiced, my tour bears out his enthusiastic endorsement. The house is a delight: compact, cozy, and obviously as easy to maintain as Harrison says it was to erect. Since the wall and roof panels have snugly interlocked joints, they wrap the living space in a sealed envelope. There's virtually no infiltration (combustion air must be piped to the student-designed fireplace), so the house is energy-efficient and nearly dust-free. It is also blissfully quiet: Looking up through a skylight, I

Continued







All-metal adaptation of post-and-beam framing depends on flanged metal posts (top photo) in X, T, or L shapes. The C-shaped galvanized joists are bolted to post flanges (inset). Holes in joists save steel, reduce weight, permit passage of wires and ducts. Tongue-and-groove edges of foam-sandwich wall panels (see inset at left) give double waterproof joint. Two men easily manipulate 20-ft. lengths and special shapes (above).

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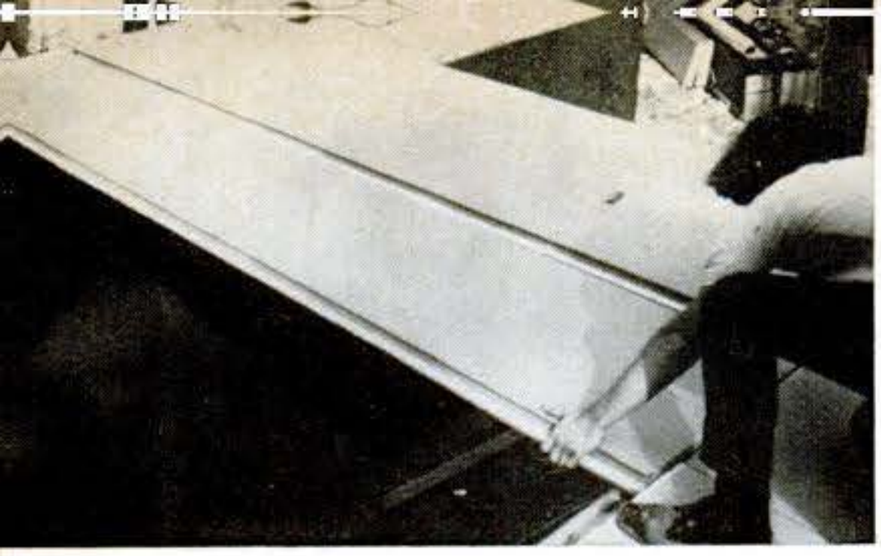
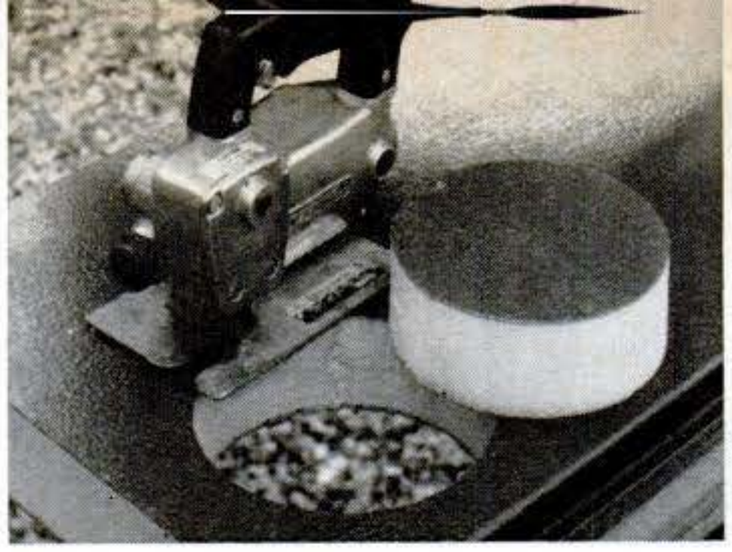
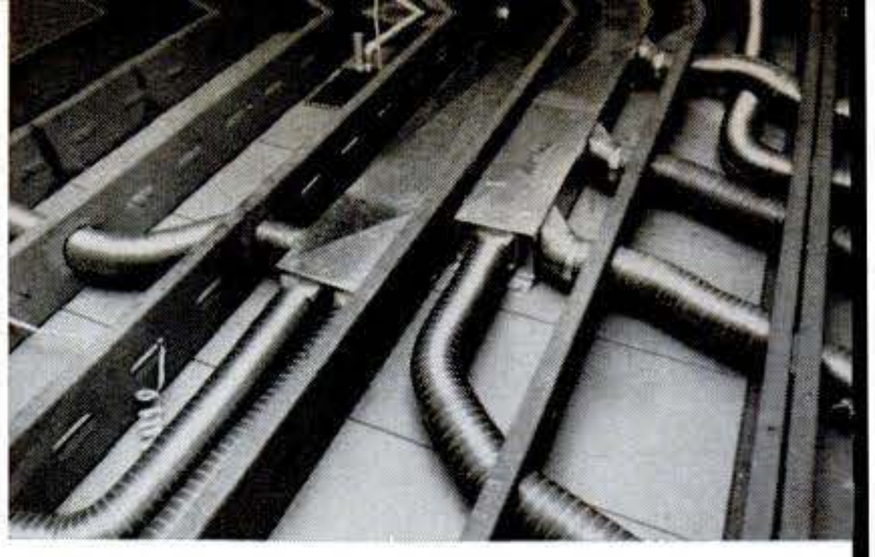


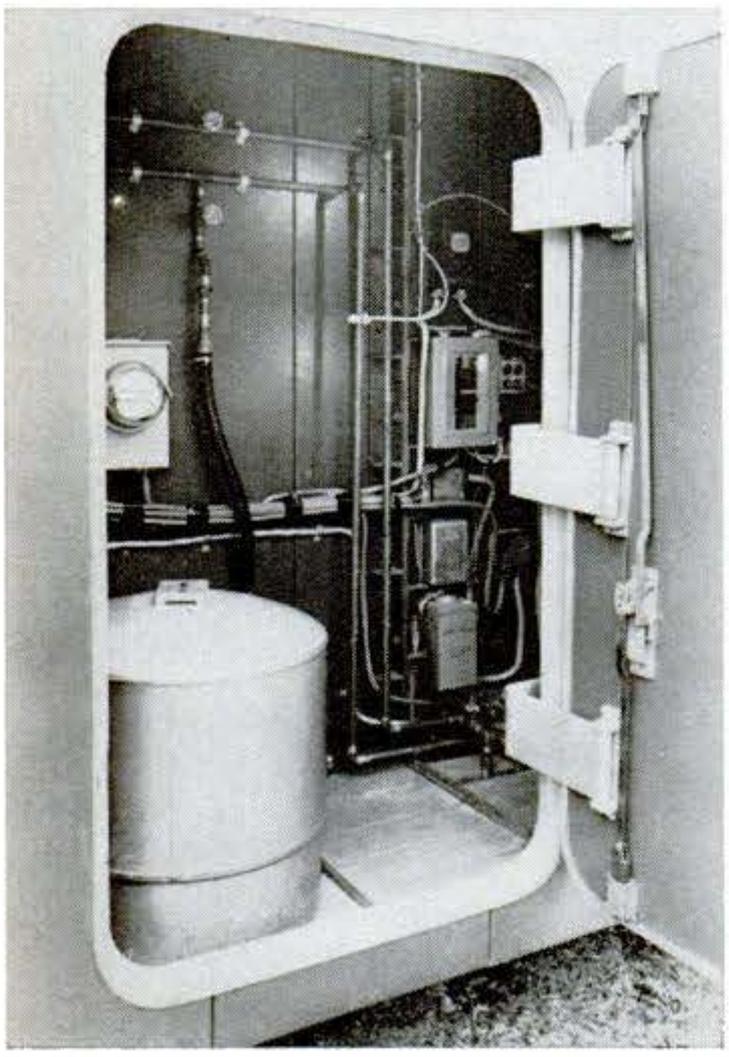
Interlocking roof panels span deck area between garage and house. All roof panels are steel-sheathed urethane foam.



Cutting vent holes (or window openings) in panels requires nothing more than a metal-cutting saber saw.



Before flooring was laid over steel joists, heating and A/C ducts of flexible steel were run to floor registers.



watch a 747 glide silently overhead.

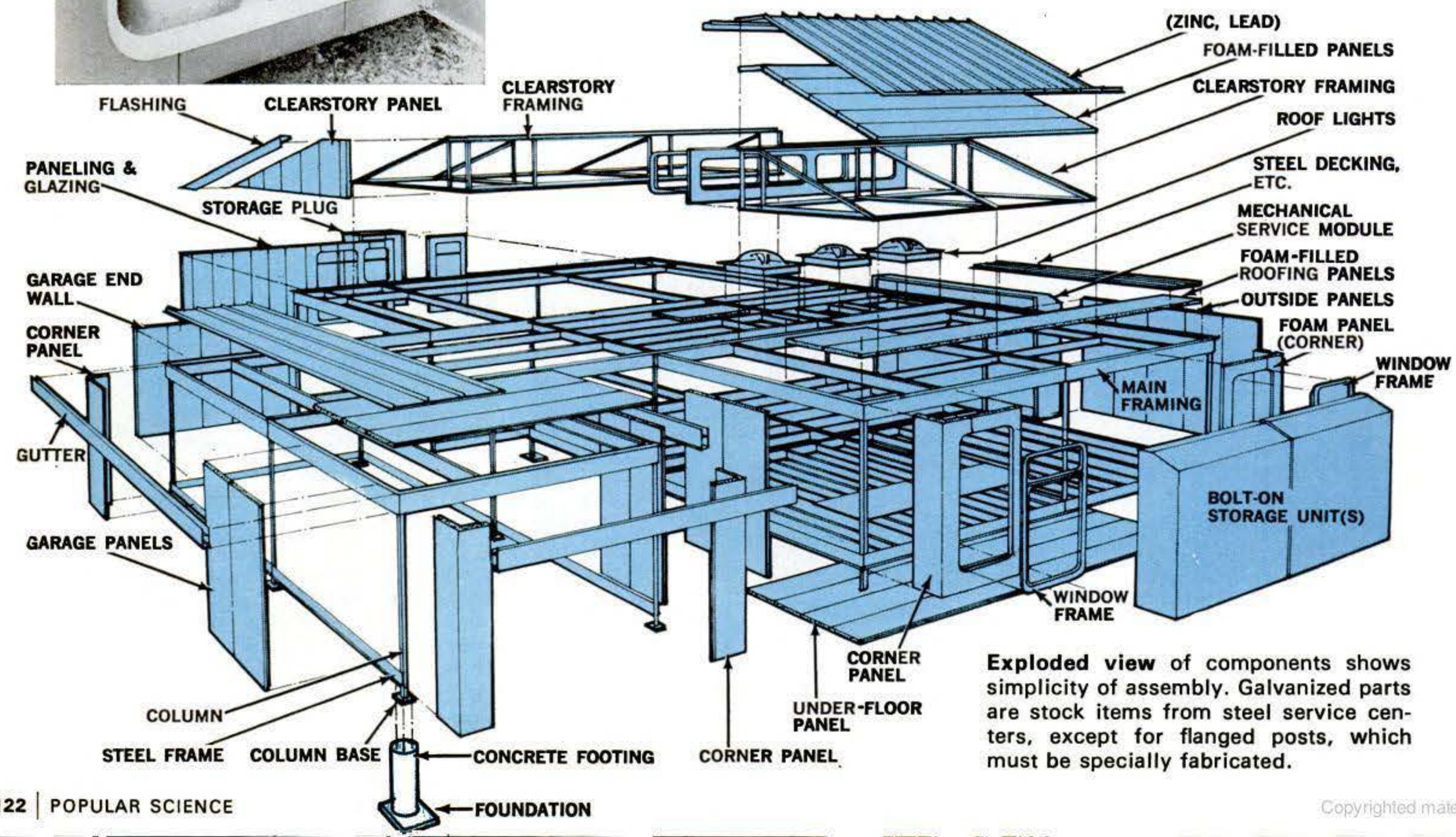
For my tour, I've picked a rather glum day, typical of New England seacoast winters. Yet these snug interiors are bright with light. The use of large glazed areas (especially on the south wall) plus two facing strips of clearstory windows above the roof—in addition to those skylights—brings daylight indoors and relegates electric lighting to evening hours.

ILZRO commissioned RISD to find viable alternatives for conventional construction materials. Their main stock in proposing steel framing and steel/foam sandwich panels was the *galvanizing* such components would require (most ILZRO members don't make the steel itself). But the RISD design team came up with applications for *sheet* zinc and lead, as well: The two roof projections that create those clearstory windows are sheathed in standing-seam lead sheets; lead sound barriers are used in interior partitions, and zinc sheet appears as a sink-surround and countertop in the bathroom. A very pliable zinc alloy was chosen for all those window- and door-frame extrusions. Harrison rounded those corners as a design element but doesn't recommend such costly customizing. The sandwich panels adapt well to standard aluminum sash.

Mostly, however, the project demonstrates that metal is a practical alternative for a home's *structural* components. Precut framing members went up with far less on-site fuss-and-fit, and those sandwich wall panels were a cinch to install. (The garage was erected in two days, with unskilled student labor.) Once the panels are interlocked and bolted down with seam clips, your wall is complete. Since the outside

[Continued on page 135]

Utility module—a bay grafted onto one side of house (left)—contains all electrical and plumbing controls, plus extra space for solar hot-water system to be added. Lead-sheet roof projection is oriented for collectors (above).



Exploded view of components shows simplicity of assembly. Galvanized parts are stock items from steel service centers, except for flanged posts, which must be specially fabricated.

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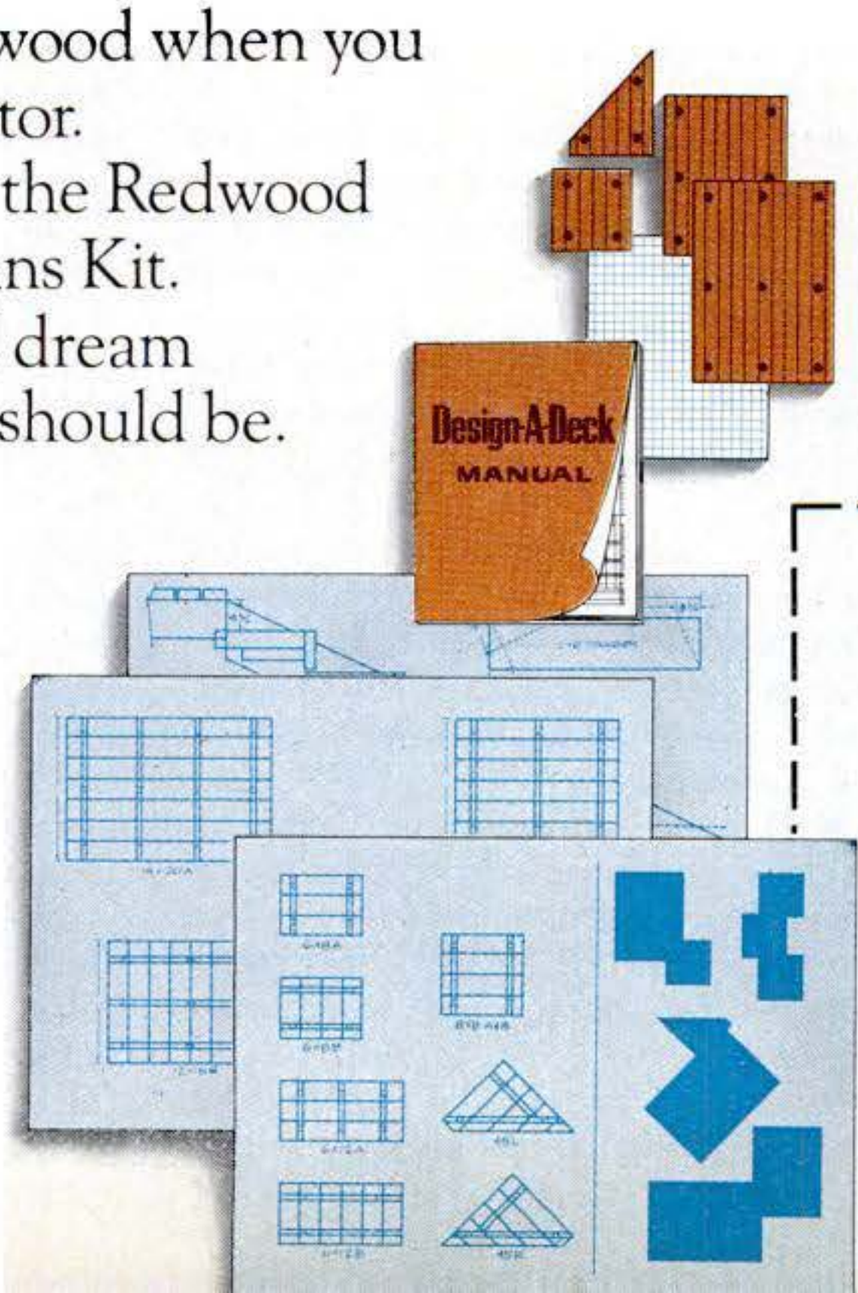

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[Continued from page 112]

stain bases. Olympic recommends latex stains for mildew-prone parts of the country.

Creosote stains penetrate deeply, provide good protection, but are available in a limited color selection. Cabot, for example, offers only 16 colors in its line of creosote stains, compared with 62 colors in one of its oil-base lines.

Alkyd formulas such as Benjamin Moore's Moorwood have great versatility. You can mix varying amounts of Moorwood opaque stain with a colorless blending base to create any degree of transparency you like—opaque, semi-solid, or semi-transparent.

Preservatives

What about wood preservatives? They make a lot of sense. They can soak into joints and the end grain around windows, doors, and trim. This provides protection to places that paints, primers, and some stains just can't reach. If you live in a humid area where moisture protection is important, a preservative stain such as Cuprinol or a formula based on creosote is a good choice. See "Preservative Stains Fight Fungus, Mildew, and Rot" in this issue for a complete report.

Opaque stains are usually based on oil, alkyd resins, or acrylic latex. Latex is easiest to clean off hands, brushes, and other staining tools. It also is most resistant to mildew. But latex stains may have adhesion problems when applied over old non-latex paints, especially if the paints are chalky. And they may cause extractive bleeding on bare cedar or redwood. Extractive bleeding—discoloration of top coats caused by leaching of wood resins—can be prevented by using a primer or by avoiding latex formulas altogether.

Preparing the surface

Putting on stains is a lot like putting on paint. You can brush, roll, pad, spray, and even dip, but the real key to a good job is proper preparation of the surface. Preparation is especially important if you plan to stain over existing paint. If you've had any paint problems, you'll have to take care of them before you stain. You can't expect stain to "glue down" old paint that is peeling and flaking away. And you can't expect a stain—even one with a mildewcide—to kill mildew already on your home. Mildewcides can only fight the growth of new mildew.

So before you lift a brush to stain over existing paint:

- Remove all loose and peeling paint with a scraper, sandpaper, or paint remover.
- Remove all blisters down to the bare wood. They're caused by moisture. If the moisture comes from inside your home, proper moisture barriers and venting should stop it. Or the moisture may be entering through cracks, open joints, unpainted areas, or around flashing. Correct these problems before proceeding.
- Check for mildew. It will appear most often in damp, shaded areas and will look like dirt. Apply a few drops of bleach such as Clorox to any suspected mildew. If it bleaches away in a few minutes, the suspect is guilty. If not, it's just dirt. To remove mildew, mix up this solution: three quarts warm water, one quart liquid bleach, ⅔ cup TSP (trisodium phosphate), and ⅓ cup detergent. Use a stiff brush to scrub the affected area with the solution. Rinse thoroughly with a hose. Let dry and finish as soon as possible to prevent formation of new mildew from airborne spores.
- Even if you have no mildew, scrub your house with detergent and water to remove surface contaminates that can interfere with adhesion. Pay special attention to the areas under soffits and overhangs. These areas are sheltered from the rain and often never get a chance to rinse clean.
- Check for heavy chalking. The best way is to press a strip of good fresh masking tape onto the existing paint. Peel it off and reapply. If the tape won't stick the second time, or just barely sticks, you have heavy chalking. Latex stains will not adhere well unless you prime first.

That's how to prepare previously painted or opaque-stained surfaces. New wood or wood that has been coated with a semi-transparent stain is easier to handle. Just do the following:

- Remove dirt, pencil marks, grade stamps, or any other markings that could show through a semi-transparent stain. Light sanding is the best way to remove marks.
- Unless you are using a latex stain, make sure the surface is perfectly dry. Some makers recommend dampening the surface with water before applying latex stains.

Applying the stain

Now you are ready to stain. Probably the best way to apply stain is with a brush. Brushing works the stain into cracks better than other methods. Use a natural-bristle brush for oil stains; synthetic brushes are required for latex stains. Special stain brushes—a little shorter and stiffer in the bristles than ordinary brushes—help force the stain into every crack and crevice.

Rollers are fine, but they won't always cover rough textures as well as a brush. And you must keep them loaded with stain at all times to avoid uneven effects. They aren't much good on shingles or clapboards.

Pads work well on smooth surfaces, but can't do the job on rough surfaces or those with a lot of relief. If you are working on shakes or shingles, a shake stainer—sort of a scrub brush with a handle—gets the job done quickly.

The fastest way to apply stain is with a sprayer, especially one of the airless types now available at rental shops. For best stain penetration, spray an area, and then go over it while the stain is still wet, using a dry roller, brush, or backbrush. For a backbrush you can make yourself, see photo on page 113.

No matter how you put stain on, you should apply it in a logical sequence to avoid unevenness and lapmarks. Proper application is most important with semi-transparent stains.

On horizontal siding, start your work at the edge of several boards. Work across to a logical break such as a window or door. Keep a wet edge at all times. If you allow one brushful to dry before putting on the next, you'll get lapmarks.

For vertical or diagonal siding, work from the top down, again stopping only at a logical break.

Work on the shady side of your house. This will prevent the stain from drying so fast you can't keep up with it. Never work when the temperature is below 50 degrees. If you decide to apply two coats of stain—for better coverage or deeper color—be sure the first coat is dry before you apply the second. Do the job right and you won't have to lift a brush again for years. PS

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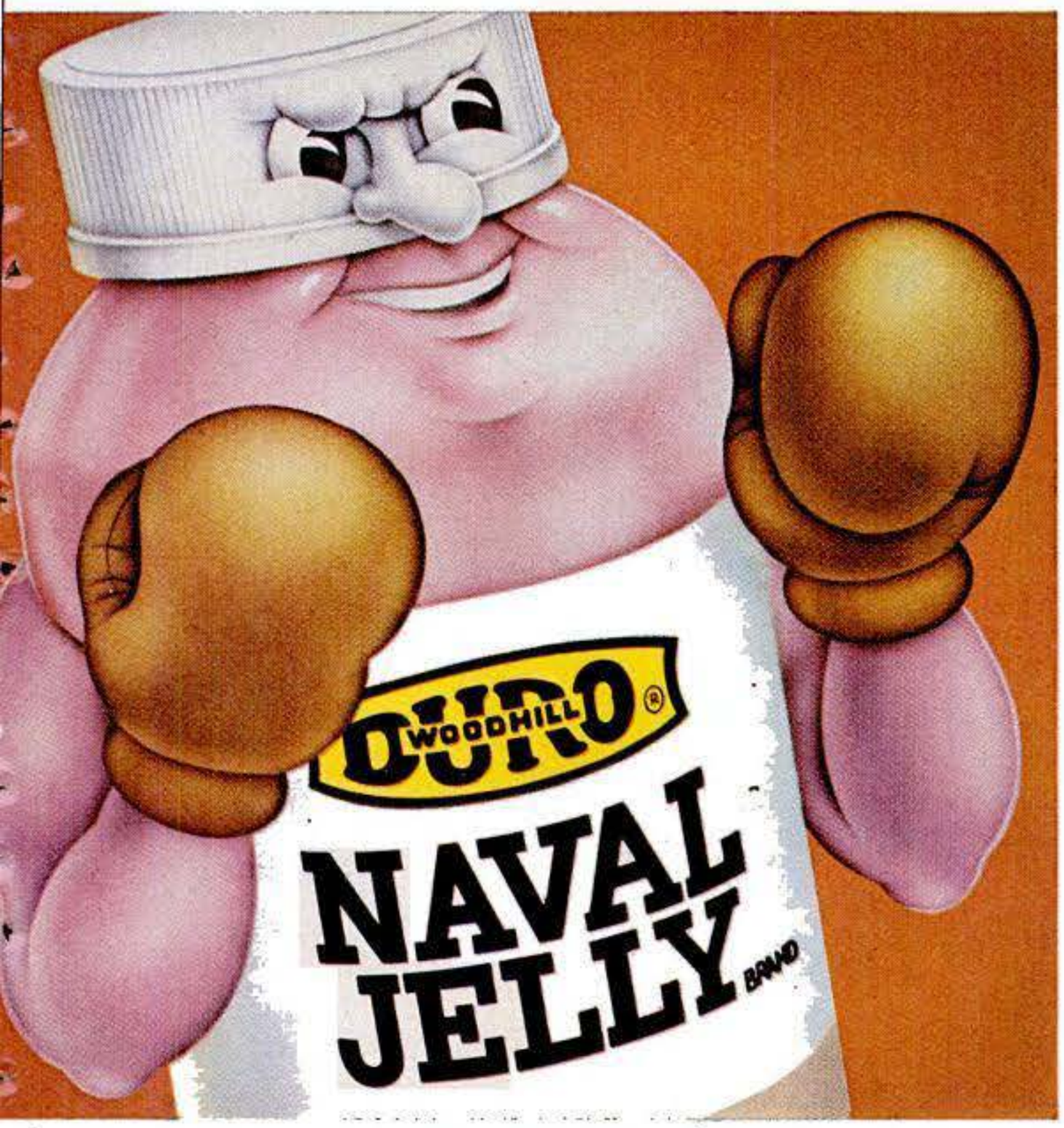
NAVAL JELLY® vs. RUST



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Preservative stains

fight fungus, mildew, and rot

Ranging from mild to virulent, fungi thrive on moisture and wood fiber

By JAMES SMITH

Several varieties of fungi that thrive in moisture can seriously damage house siding and other exposed exterior wood. These microorganisms usually become visible as discolored or spotted areas. But these spots are more than just an aesthetic problem; they warn of a problem that can be much more serious. In ideal growing conditions fungi can destroy unprotected wood in as little as two years.

While their destructive activities are slowed or halted in cool, dry seasons, fungal spores are among the hardiest known. Molds found in Egyptian tombs, for example, have resumed vigorous growth after lying dormant for more than 2000 years. Given that kind of persistence, the message is clear: You can't afford to ignore evidence of mold or mildew on your house siding.

Unprotected wood readily absorbs water from exposure to rain, snow, and high humidity. Besides causing the wood to swell, the added moisture provides a happy medium for rapid fungal growth. The water evaporates and the wood returns to normal size in dry weather, but the continual cycles of swelling and shrinking eventually cause the wood to crack, warp, and split. Meanwhile the fungi hang in there, awaiting the next feeding opportunity.

All modern stains contain ingredients to control mildew. Some stain makers custom-blend their stains for different parts of the country. Stain for the Gulf States—a real mildew hotspot—may contain a stronger dose of mildewcide than stain mixed for the Southwest.

There are mildewcide additives on the market, but stain and paint makers usually advise against them. They can interfere with color retention, especially when added to latex finishes. Some types also break down and lose effectiveness when mixed with water-based stains. Stay

Continued

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We make siding a little differently than anybody else. The bottom of each panel is squared off to look exactly like wood clapboards. And we invented the natural woodgrain texture you see on our Branded® siding.

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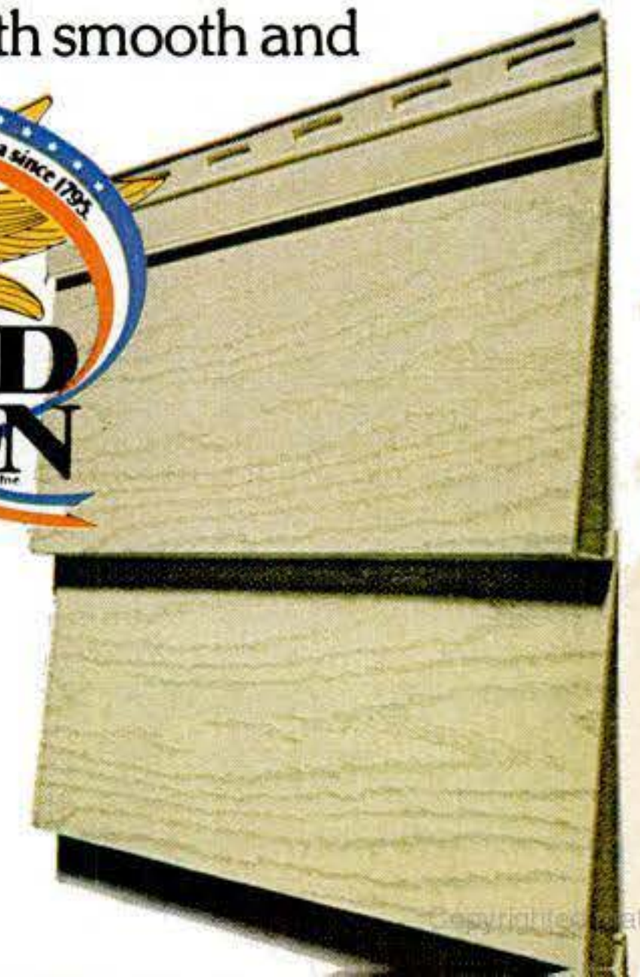

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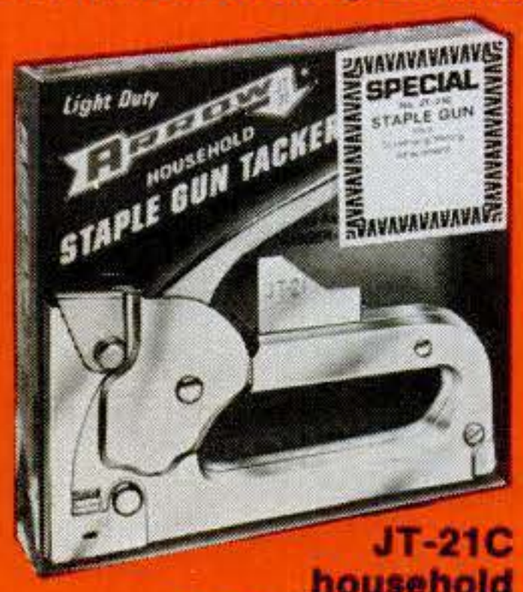

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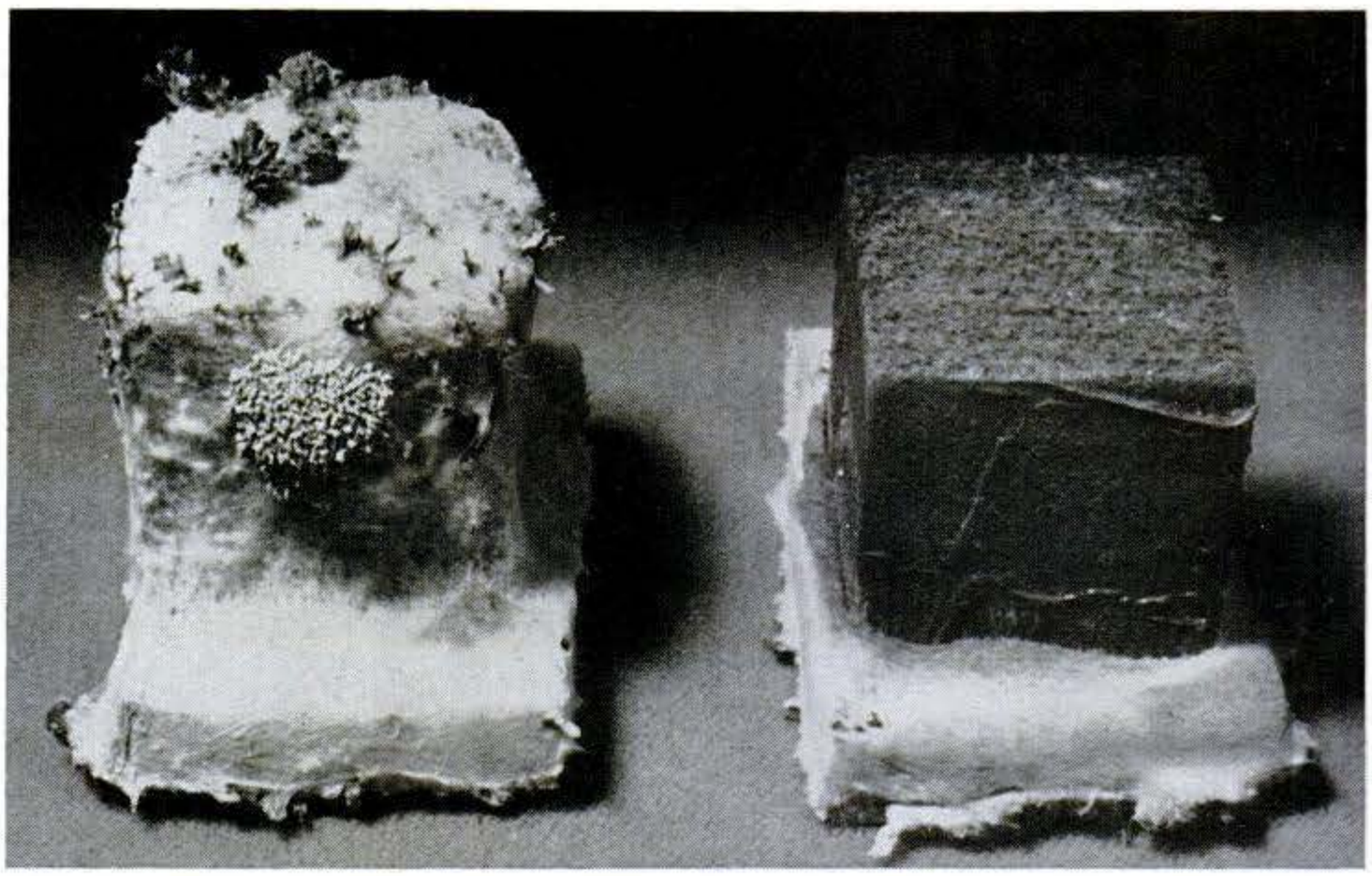
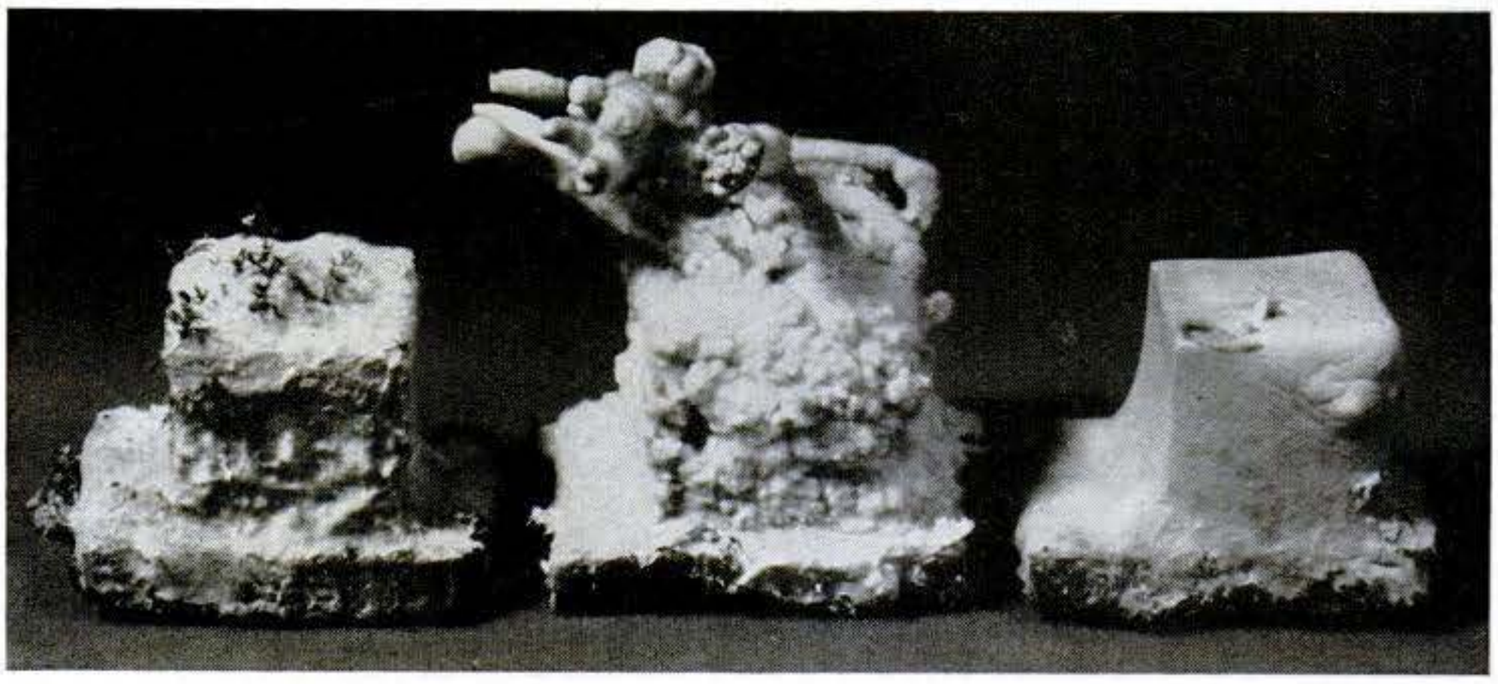


Wood samples (untreated on left, TBTO fungicide-treated on right) were infected with wood-digesting organisms and placed on soil mixture in bottles at 80° F and 70 percent humidity. They're shown after 12 weeks exposure.



Three types of parasitic molds: *Lenzites trabea* (left), which has done the most damage to woods in tests; *Lentinus lepideus* (center), a less virulent fungus; and *Poria monticola* (right), which does little damage to wood in tests.

away from additives unless they are specifically endorsed by the maker of the stain.

The traditional defense for any wood, new or old, is a two-stage operation. After applying a clear, water-repellent preservative that includes an active fungicide, you top it off with a coat of paint or penetrating stain. Water repellency keeps moisture absorption of the wood to a minimum, limits the effects of weather cycling, and generally makes life difficult for the mold.

An equally effective defense is a time-saving single-stage finish that incorporates stain, water repellent, and preservative-fungicide in one mixture. Cuprinol is one such stain. It includes in its formulation the fungicide tributyltin oxide (produced by M&T Chemicals as bioMeT TBTO antimicrobial), which unlike now-banned mercury-based fungicides and mildewcides, is approved by the Environmental Protection Agency. TBTO safely focuses its fungus-fighting action on a broad spectrum of wood-digesting microorganisms.

Surface preparation

For ways to remove mildew and apply stains, see "Exterior Stains—Best Finish for Your Home?" in this issue. Of course, if exposed wood has deteriorated to the point that it is spongy or rotted, you should remove affected boards or shingles and replace them with new, sound wood. As an extra precaution, thoroughly wash the surrounding areas with a 1:1 mix of water and chlorine bleach to remove any fungal growth that may not be visible to the naked eye. PS

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SOLID STATE ELECTRONIC CONTROLS

now makes painting almost anything easier, more convenient, faster! The ideal paint gun for farm and home use!

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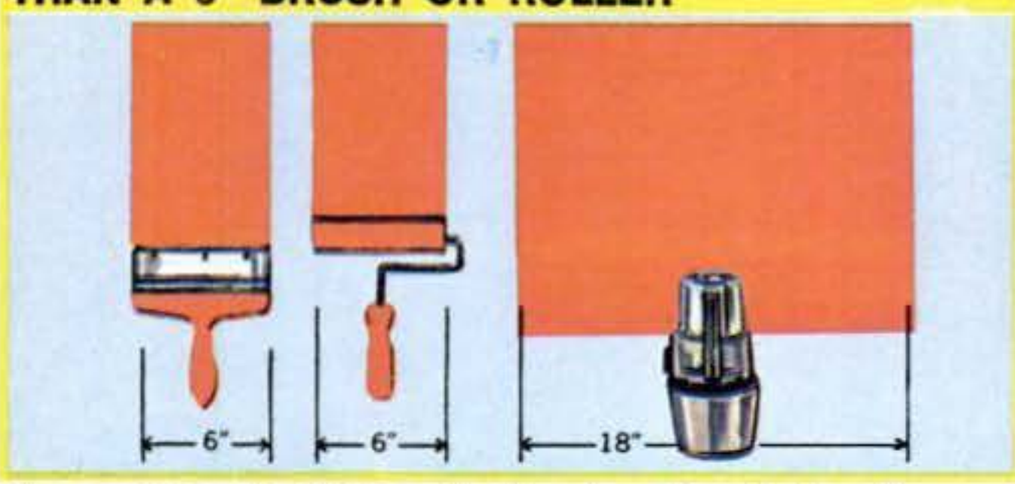
No more of this —eliminates need to cover everything in the room!

Cuts overspray and misting —reduces masking and touching up to a minimum

COVERS 300% MORE WIDTH IN EACH STROKE THAN A 6″ BRUSH OR ROLLER



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Only 10″ high

New! Self Centering Adjustable Gate gives you pre-selected width from ½″ to 18″

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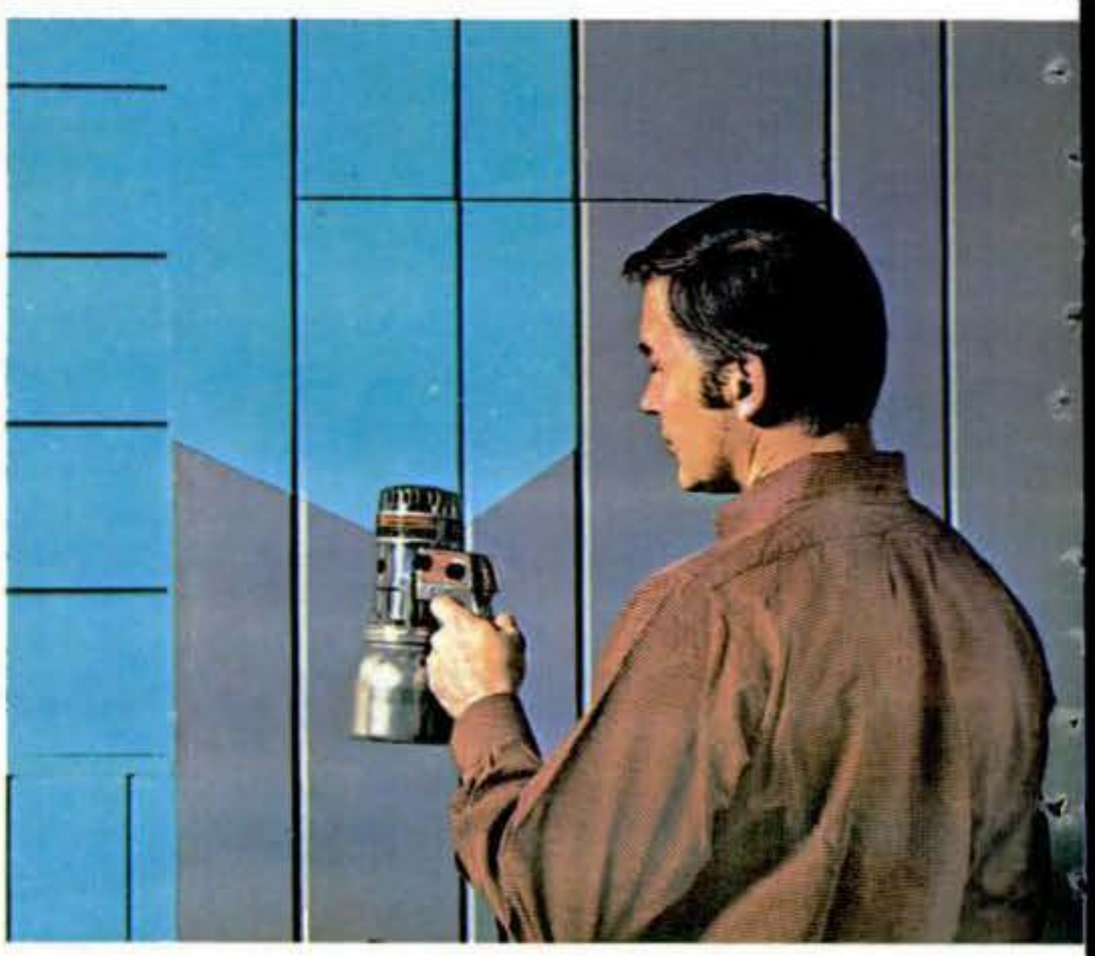

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Paint furniture

Wax floors

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Paint louvered doors

Paint radiators and pipes

Disinfect rooms

Patent Pending

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All-metal house

[Continued from page 122]

surface is factory-finished, it should never need repainting (unless you tire of the color). And since your insulation is already in place, you can simply leave the prepainted interior surfaces exposed as your finished wall. (Harrison devised clever ways of hanging pictures and wall clocks from hooks anchored in the seams.)

Special shapes, such as for this home's bay sections (as shown in the small photo on page 121), can be customized on site. The angled "roof" portion of these panels was formed by removing a strip of the interior metal face and cutting a V-groove across the foam core. The uncut exterior face was then bent back to close the gap in the foam, providing a continuous leak-proof bend.

The rigid, interlocking panels need no stud support, so the only framing member you must deal with is an occasional post. Harrison just caps these, inside, with prefinished metal channel—removable, since these vertical gaps are utilized as wiring raceways.

Interlocking panels also simplify roof assembly. After laying the panels in place, one by one, all joints are caulked and the whole surface is then covered with asphalt and gravel.

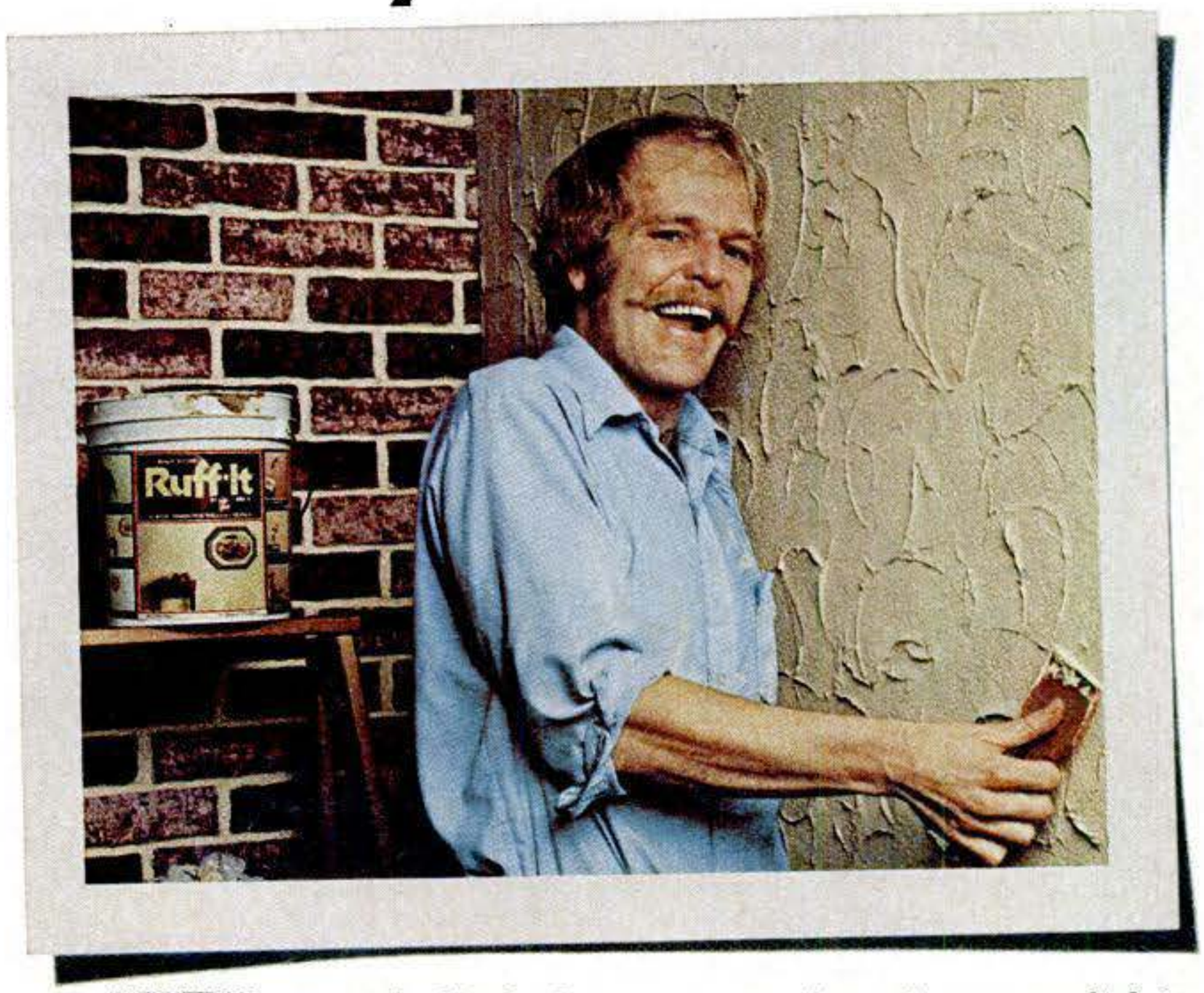
For your next home?

Though you can't yet duplicate Harrison's experiment for ILZRO without having some units custom-fabricated, commercial builders in various parts of the U.S. are now erecting homes from similar component systems. Touring with me, here, is Gene Buckley, president of an Oklahoma company specializing in multipanel construction. Buckley, who imports his prefinished metal components from Mexico, finds working with steel/foam sandwich panels quick and easy, and his all-metal houses sturdier, tighter, cleaner, and easier to heat and air-condition than conventional wood-frame homes.

As lumber rises in price and declines in quality, metal and plastic substitutes look ever more attractive—especially since lightweight panel components can be manufactured in volume and shipped anywhere for fast on-site assembly. And Harrison's ILZRO house is a striking example of the special contemporary look and feel such homes can have. I'd move in tomorrow. PS

New Ruff-It T.M.

lets you sculpture bold, rough walls yourself!



"HEY, you'd think I was a pro but I never did it before in my life! The secret is Ruff-It, an acrylic finish that's easy to use because it doesn't set up too fast. You can try all sorts of dramatic effects . . . smooth it on, rough it up with a trowel like I'm doing, pattern it, carve it with a spackling blade, brush it, comb it or actually sculpture it with your hands!

Ruff-It is neat because it's ready to use—no messy mixing or measuring. It's crack-resistant. And it comes in 6 colors that go great with the warm, rustic colors in our Z-Brick walls. That's how we got a terrific wall and ceiling, too, without paying an arm and a leg for it."

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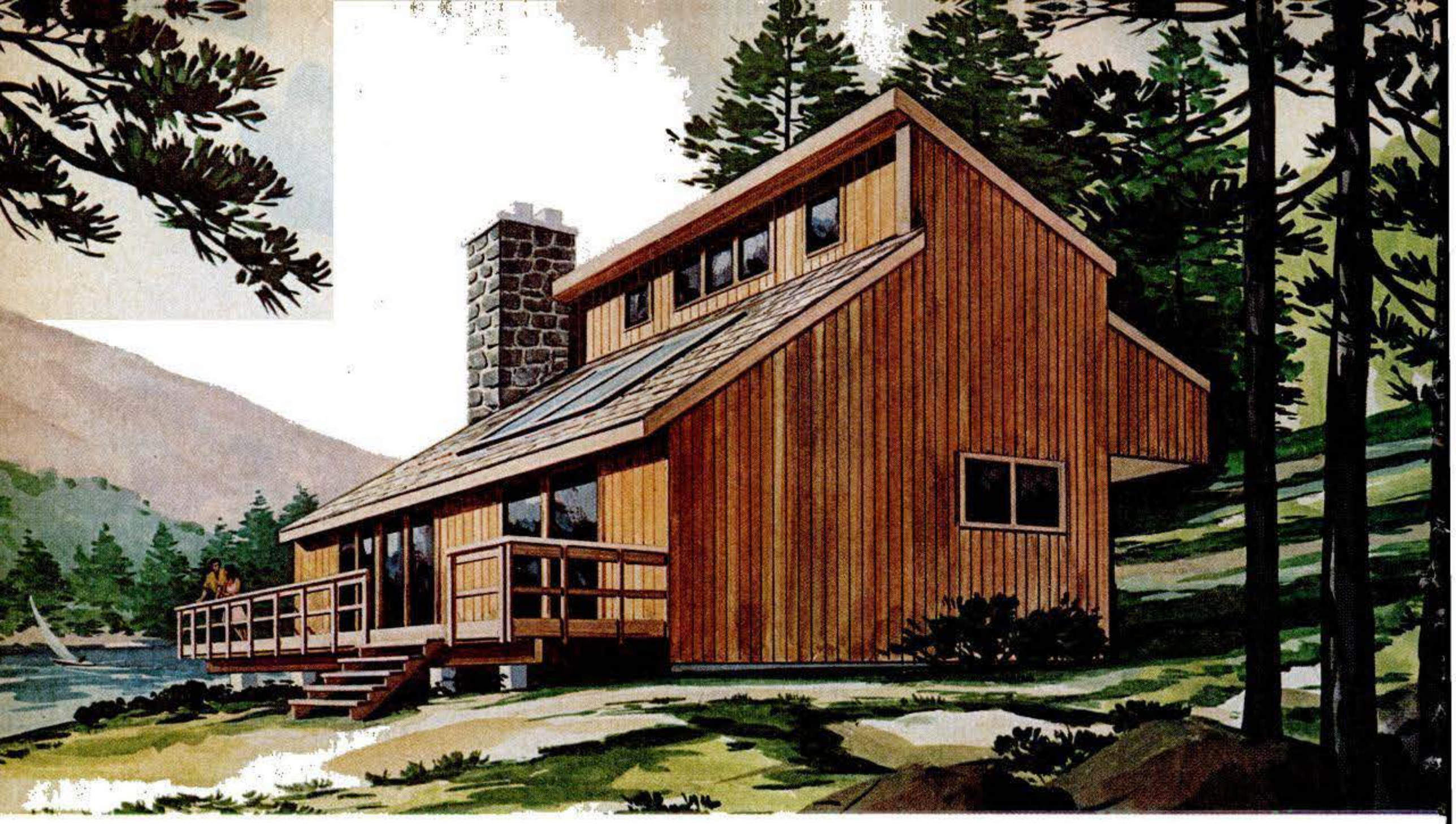

PS leisure-home plan

Sky Vista
has stacked bedrooms

By AL LEES

This house look familiar? We liked it so well we've used a sketch of it as the logo throughout our home-improvement section in this issue. The house, designed especially for PS by architect Samuel Paul, would fit into any vacation setting, mountains or seashore. The exterior components—vertical cedar or redwood siding, stone chimney, opposing roof slopes with clearstory windows, cantilevered balcony—all relate to nature in a unique way. And contemporary technology is represented by a pair of solar collectors that supply the home's hot-water requirements.

Solar makes special sense

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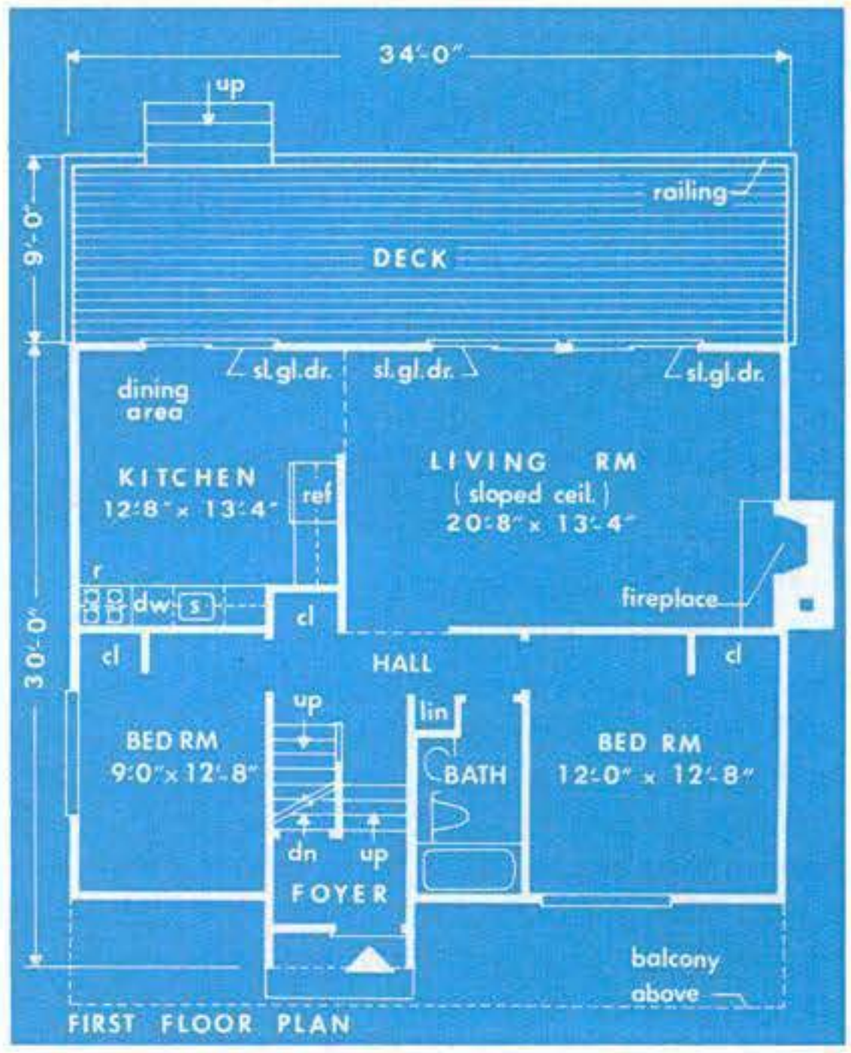
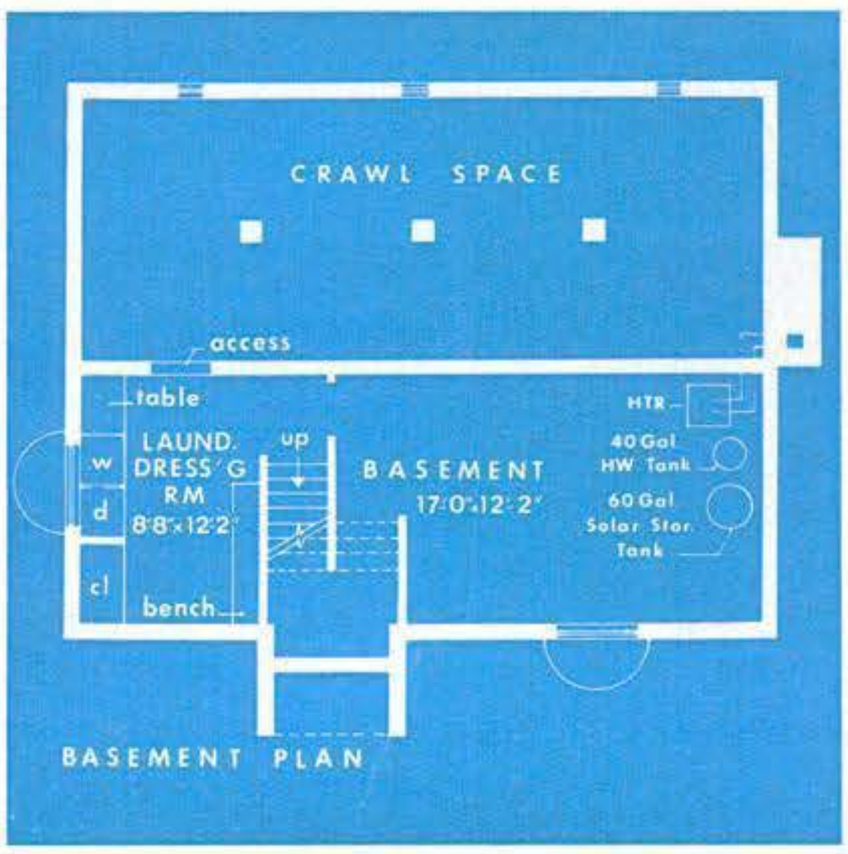


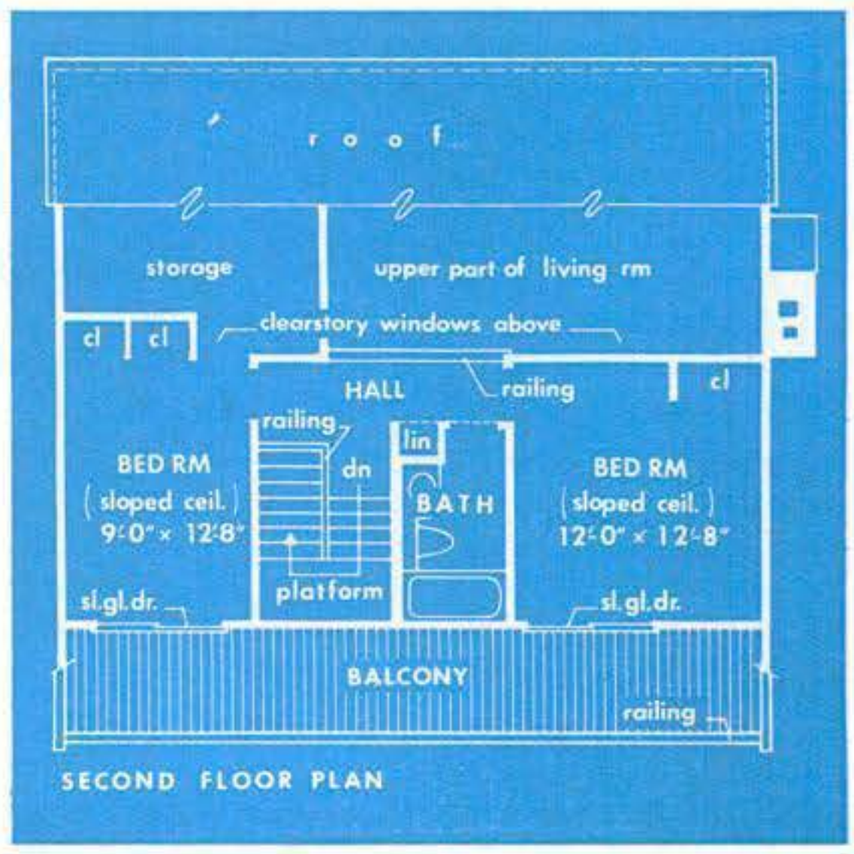
FIRST FLOOR PLAN

How to order your plans

One set of detailed, professionally drawn blueprints for the Sky Vista is $59; four sets (for construction, financing, obtaining permits), $75. Materials list and specifications included at no extra cost. Plans can be reversed, left to right, for $10. Address orders or queries to Homes for Living, Inc. (specify Plan No. 9228), 107-40 Queens Blvd., Forest Hills, N.Y. 11375. Add $3 for handling (all mailings are first class for fastest delivery).



BASEMENT PLAN



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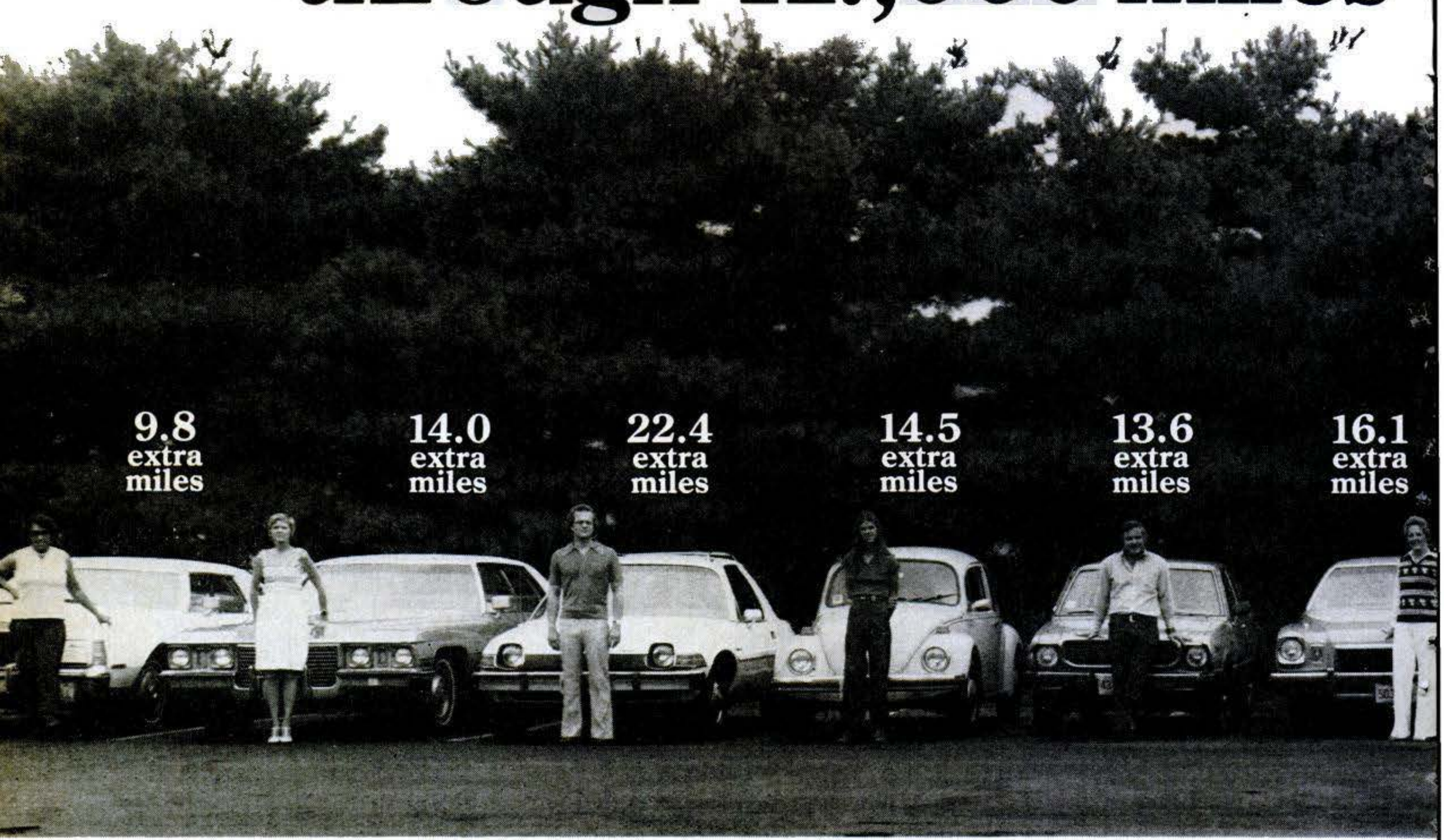

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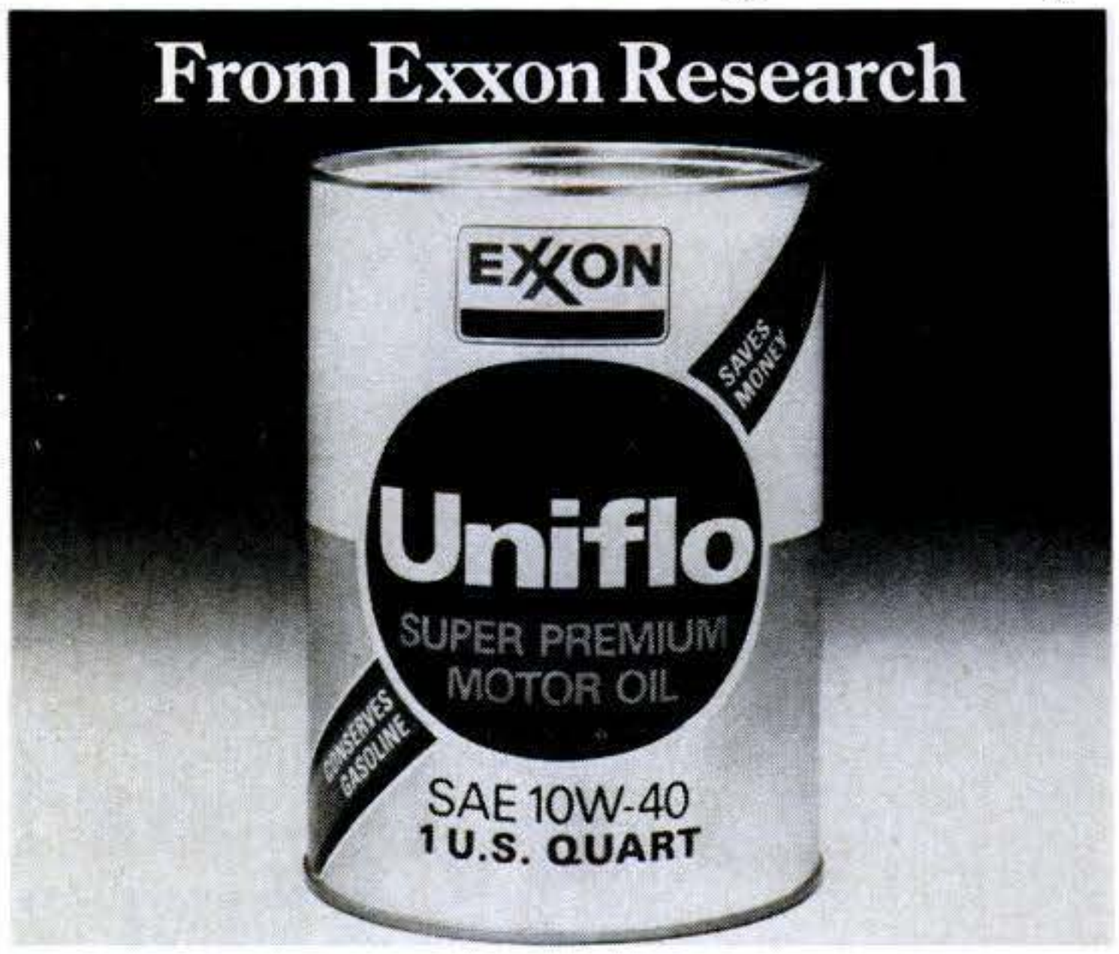
The 19 cars in this fleet were typical of cars you're likely to drive.

They ranged in size from a VW to a Cadillac.

People who were not professional drivers took all 19 cars over the same route, day after day.

They drove like you drive—in city, suburban and highway traffic—while we measured the gasoline they used. Here's what we found:

Compared with a typical high-quality multi-grade oil, Uniflo demonstrated measurable gasoline savings



Uniflo is not a synthetic, but a super-premium multi-grade oil containing special friction reducers developed by Exxon research.

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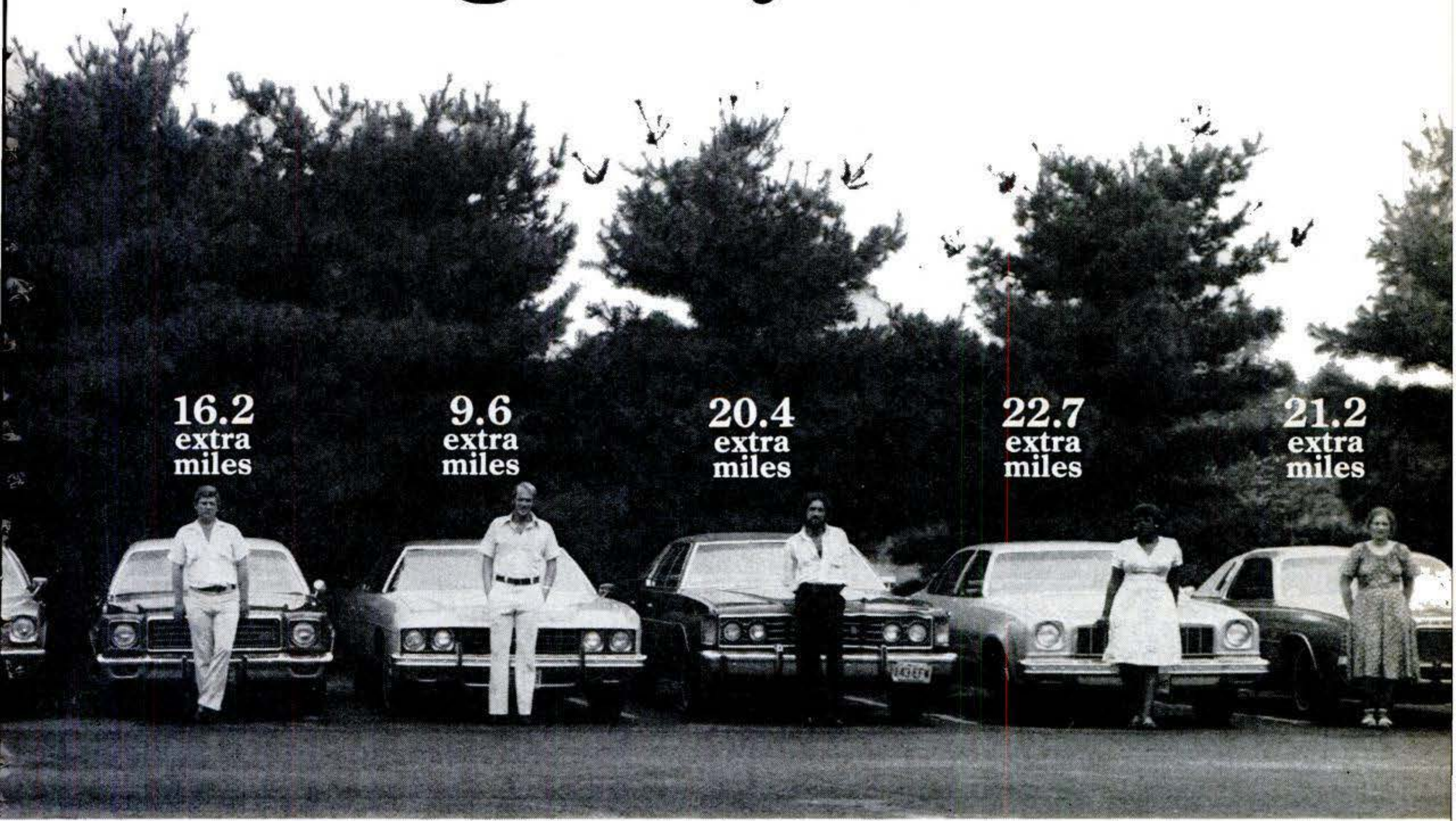

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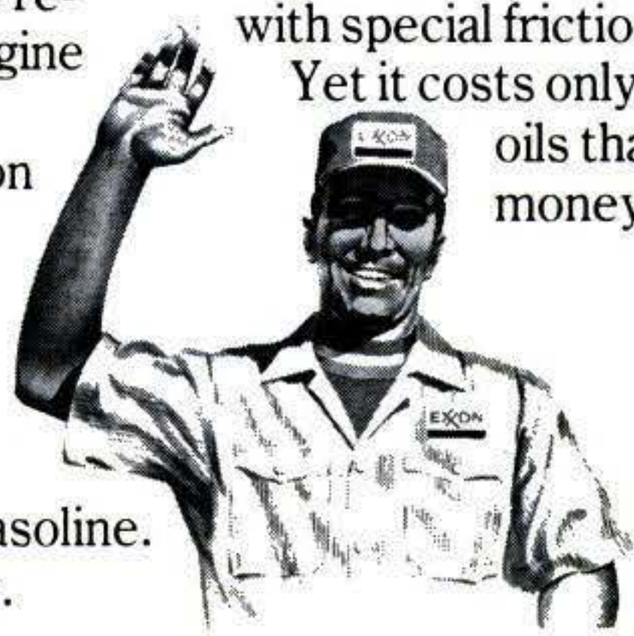

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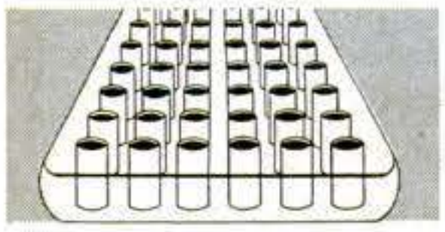

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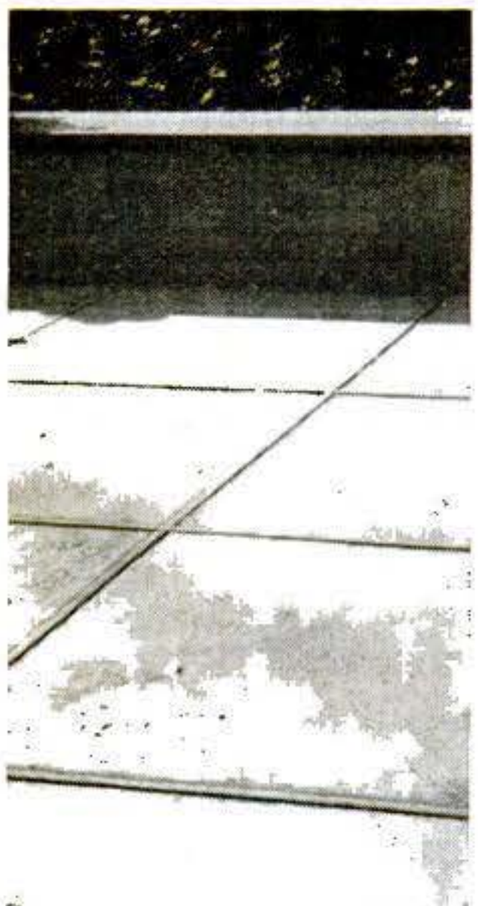

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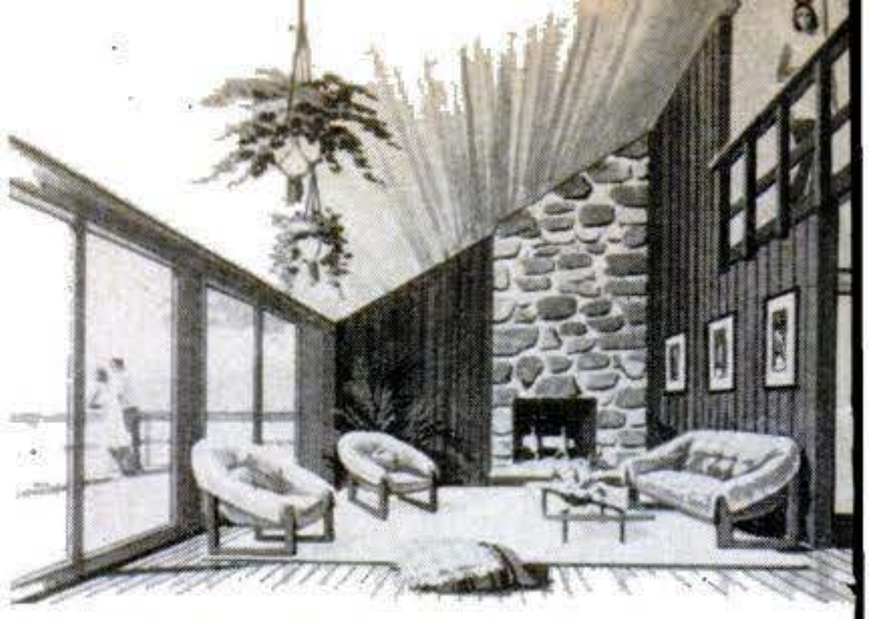

Viewed from kitchen, living room soars from one to two stories. On roof above sloped ceiling are solar collectors.

for a weekend home, since the collectors can be storing and maintaining a hot-water supply while you're away, avoiding the heavy power drain of starting from scratch on your arrival. Because of the extra time the system has to build up the supply, you should get by with the plates shown.

Chances are that the house will be steadily occupied only during the vacation period when the sun's giving its best performance.

Although the outside dimensions of this house are only 30′-by-34′, it packs in a lot of living space by stacking one pair of bedrooms on top of the other. The two bathrooms are also stacked for efficient plumbing runs. Below the tall bedroom section is an excavated basement that offers a combined laundry-dressing room (for swimmers or skiers) and space for the solar system and an optional furnace.

The living room slopes dramatically from the single-story window-wall along the deck side to a balcony overlook along the opposite side, as shown in the sketch above. At one end of this room is a rustic stone fireplace from floor to ceiling. The other end opens to a country-style eat-in kitchen, which has its own access to the deck to facilitate outdoor dining. This room has a conventional flat ceiling that provides storage above.

The main entry is recessed and protected with a canopy. It leads into a foyer and up four steps to the main hall, with first-floor bedrooms right and left. You continue up the turn-around stairs to the second floor; the bedrooms here duplicate those below, except for their sloped ceilings. The hall balcony overlooks the living room and is flooded with light from clearstory windows above; each upper bedroom also has a clearstory peep at the open sky.

The opposite wall of both bedrooms features a sliding glass door that gives onto a cantilevered deck. Its closed ends make it ideal for sunbathing. PS

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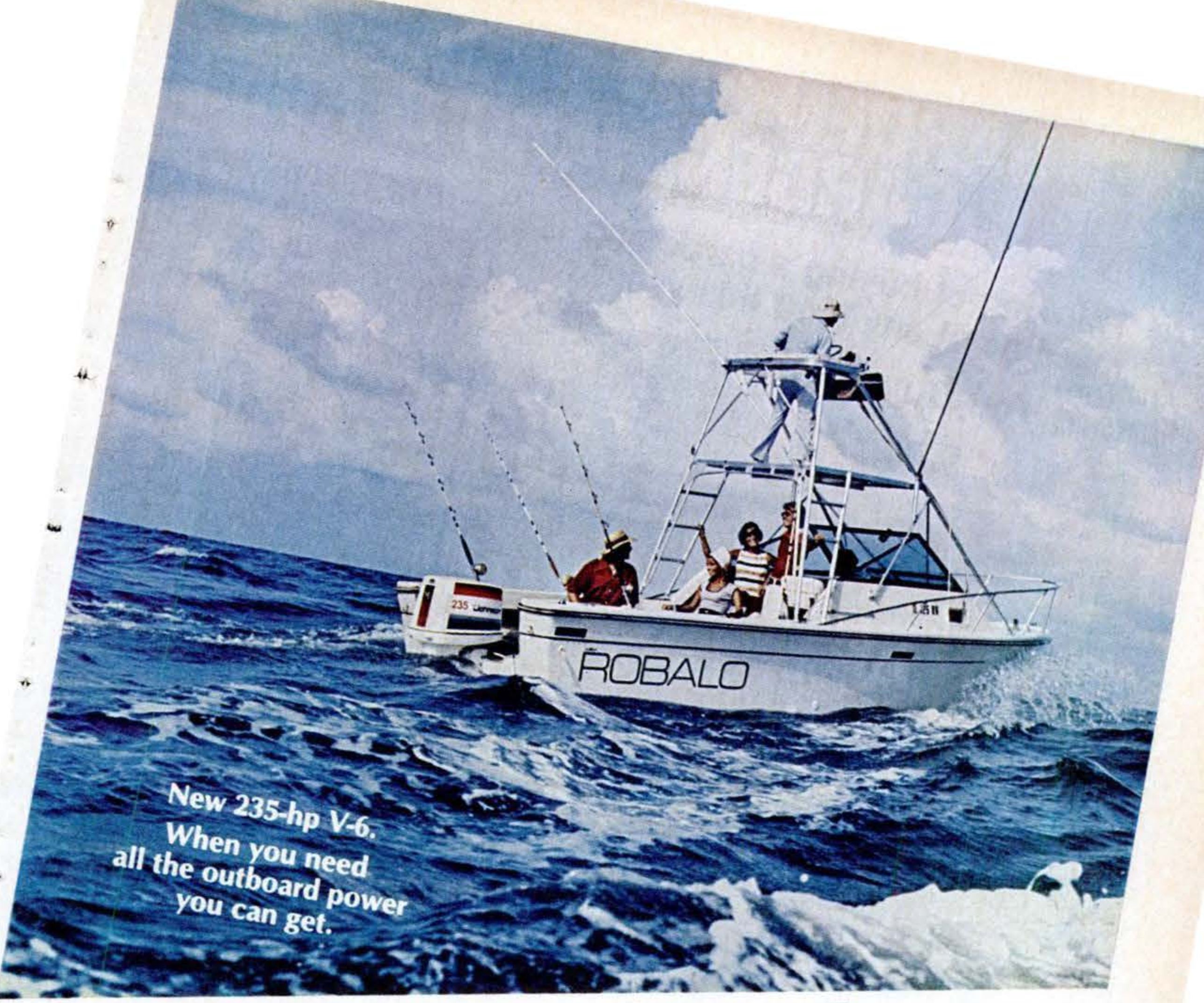

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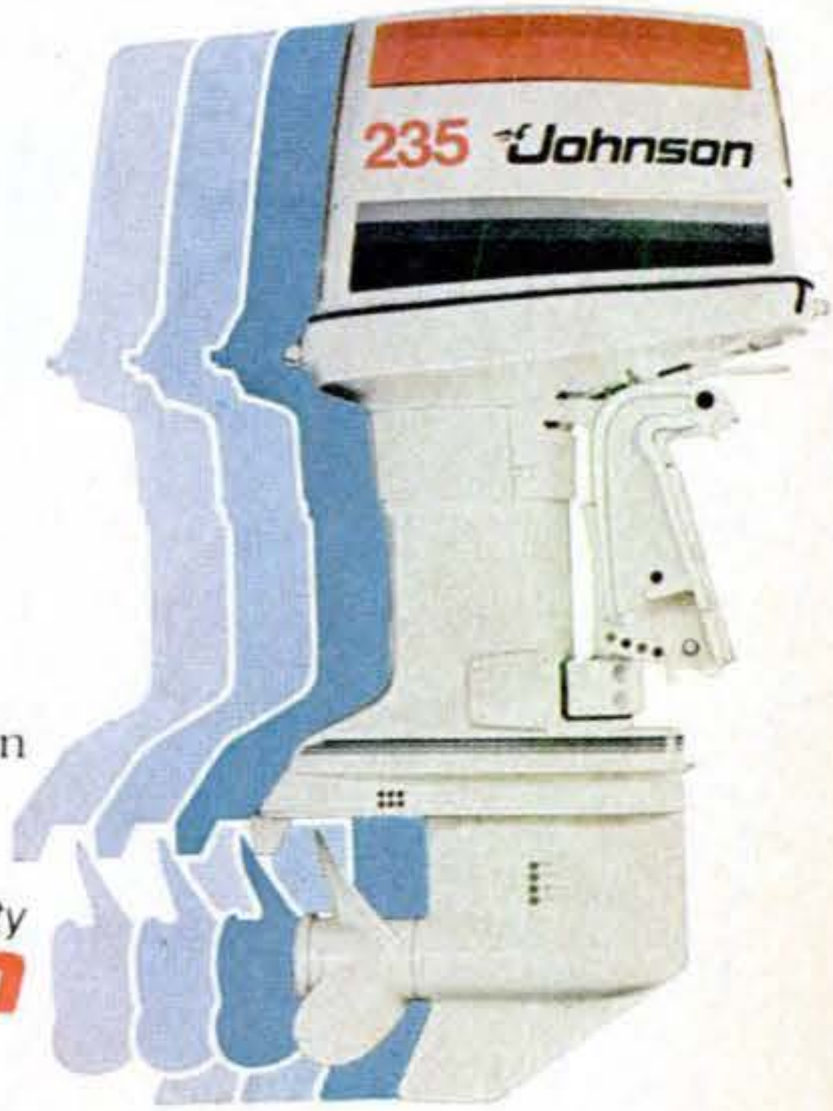
Under Outboard Motors



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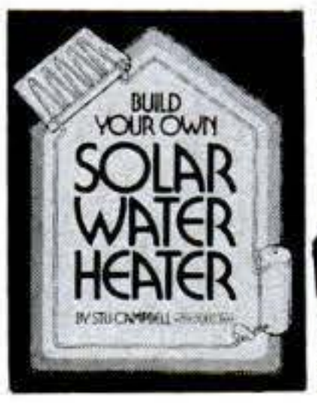

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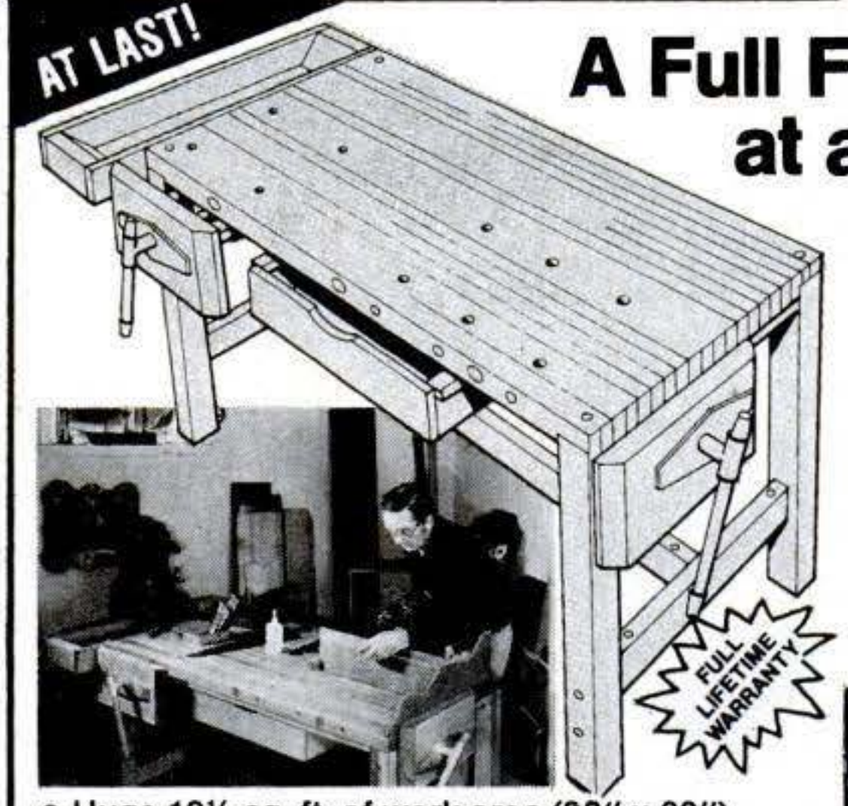

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HOUSEPOWER CLINIC

By EVAN POWELL

About use tests . . .

When new products go on the market, usually they've been tested only by their manufacturers, who are naturally inclined to devise and publicize tests that show their own product in the best light. Our PS use tests are intended to sort out the claims and tell you what it's like to live with the gadgets.

When I do such a test, I first gather all of the available information from manufacturers and any available data from independent testing labs. Then I obtain samples of the products and use them, following all installation and operating instructions. I try to determine every advantage and disadvantage a homeowner might encounter. If a device promises to save money or energy, I try to measure the actual savings and calculate the payback period.

But such tests often don't end with the publication of the story. Such has been the case with my August '77 story on bathroom water savers. While the great majority of reports from readers agreed with my findings, the manufacturer of Eco-Flush, a two-level flush valve, and a plumbing contractor, both in Ohio, questioned my review of this device, which they felt was unjustly negative. They also maintained that toilets with dams in the tanks, and those designed by the manufacturer to use less water, can cause sewers to clog because there is too little water available to flush solids and foreign matter (sanitary napkins, disposable diapers, cigarettes). A service call from a sewer-maintenance firm, they point out, would destroy any economic advantage of such a device.

Actually, I didn't consider my evaluation of the Eco-Flush to be negative. My biggest objection was that installation required removal of the tank. But I haven't encountered any problem with sewer blockage from the toilets equipped with other devices. Three homes were used in this testing—which still continues. One home is three years old, one about 15, and the other about 32. Their sewer lines meet all applicable codes for slope and installation, as I would expect. And I don't recommend indiscriminate flushing of foreign material, whether or not the toilet has a water-saving device.

After this relatively prolonged testing period, the Eco-Flush and the other water-saving devices continue to perform as intended. I am now also testing two other two-level systems. If you have ever had problems with sewer-line blockage, the Eco-Flush or one of the other two-level systems may indeed be the safest way to reduce your toilet's water consumption.

Combination appliances

Arthur D. Little, Inc., of Cambridge, Mass., has just completed a study for the Department of Energy on the feasibility of reclaiming waste heat from home appliances. The study's findings point to three dual-purpose appliances as promising candidates for saving energy. The first is a combination central air conditioner and water heater. Heat from the air conditioner's condenser would be recovered by a heat exchanger for water heating. The second is a combination furnace and water heater, which would use a single burner to provide hot water and space heating. The third is a commercial range and water-heater combination,

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with a heat exchanger located in the vent hood. (It would not be practical for home use because of the limited "on" time.)

If these concepts seem familiar to you, it's because several of them have been explored by PS readers who have shared their ideas in this column. Still, the study may prompt manufacturers to put such ideas into production.

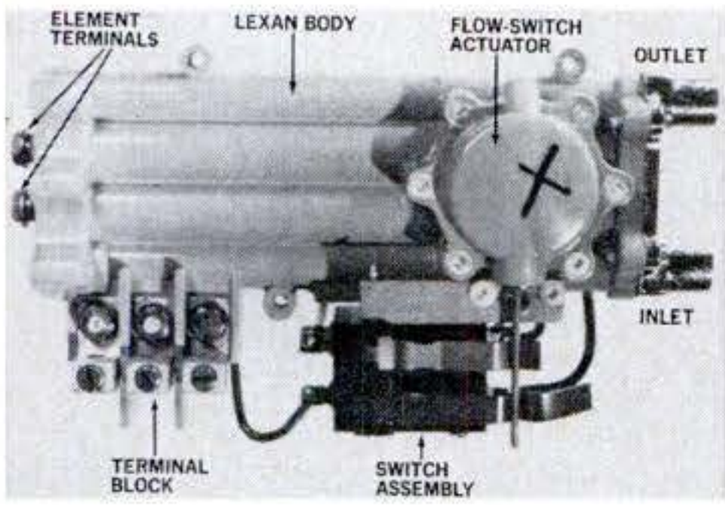
Q&A Point-of-use water heaters

In the PS story about building a "Warm Room" (Nov. '77) you used In-Sink-Erator's Ultra-Hot system as a point-of-use water heater. What is the feasibility of placing point-of-use water heaters throughout the home?

L. Esposito, Menands, N.Y.

First, you should be aware that there are two types of point-of-use water heaters. One type, like the Ultra-Hot I used in the Warm Room, has a storage tank, but the tank is very small—it fits right under the sink. Such a unit is hooked to the cold-water line and can serve a kitchen sink very well. It includes a mixing faucet that provides a complete range of temperatures from cold to hot, along with pushbutton dispensing of 190-degree water for instant beverages. These units do avoid heat loss in plumbing lines, but they are intended to supply hot water in small volumes only and are thus not suitable for most household applications.

The other point-of-use system is an in-line instantaneous heater, like the Instant-Flow from Chronomite Labs, Inc. (photo below) that I use to boost hot-water temperature to my kitchen sink and dishwasher after turning the thermostat on my regular water heater down



to 120 degrees (see sidebar of our February "Water Heaters" story).

It's possible to use such units throughout the house, but each costs nearly as much or more than a standard 42-gallon water heater. When you consider the number of hot-water outlets, the payback period stretches far into the future. Also a separate electrical circuit must be run to each. My unit is a small 115-volt model that is suitable for dishwasher needs, but would never meet the requirements of a shower or tub. And still it required a 30-amp circuit. These heaters must be sized carefully since water temperature at the outlet is determined by the flow rate.

My recommendation: a centrally located energy-efficient storage-type water heater set to 120 degrees with an in-line heater as a booster for the dishwasher. In terms of cost, efficiency, and convenience, this is the ultimate combination for my money.

Controlling condensation

The window in one room of my home sweats as though a water hose were turned on it. There is no heat in the room. The walls don't have the problem, but they are cold.

It's been suggested that I double glaze. Are there alternatives? The moisture is so great that mildew has formed on the curtains.

Al Horowitz, Torrance, Calif.

The answer is to reduce the humidity in the area. If your home is built over bare earth in a crawl space or basement, lay down a ground cover of polyethylene to reduce moisture. Then obtain a hygrometer or sling psychrometer to measure the humidity. Proper level should be around 35 percent. A ground cover should take care of your problem and save you the expense of other methods such as a dehumidifier. PS

Got a home-equipment problem?
Write to Evan Powell, Housepower, 108 Morningdale Dr., Greenville, S.C. 29609, giving appliance make and model number. Sorry, but questions can't be answered by mail.

Some houses were never meant to be painted.

Architect: Architectural Workshop—Moscow, Idaho. John Anton Berg—Designer

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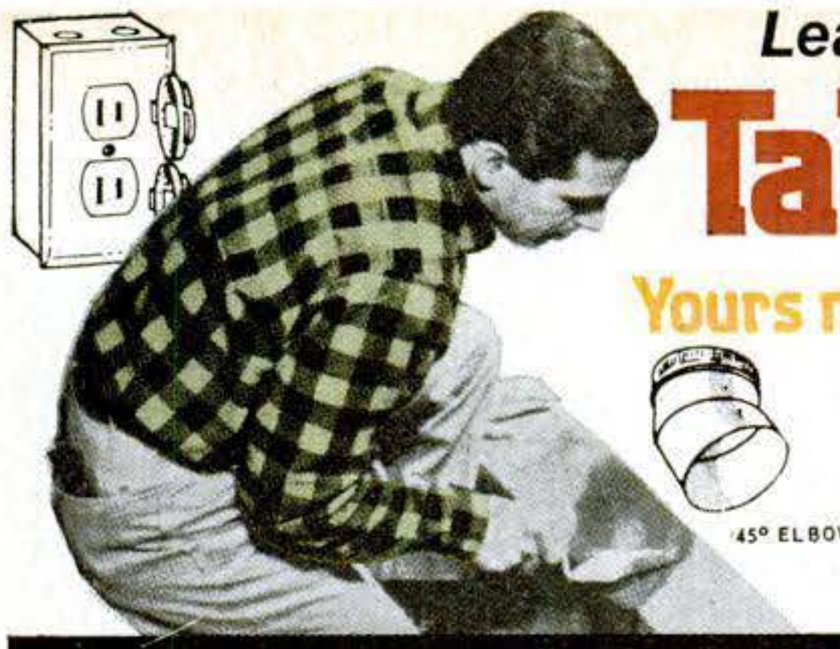

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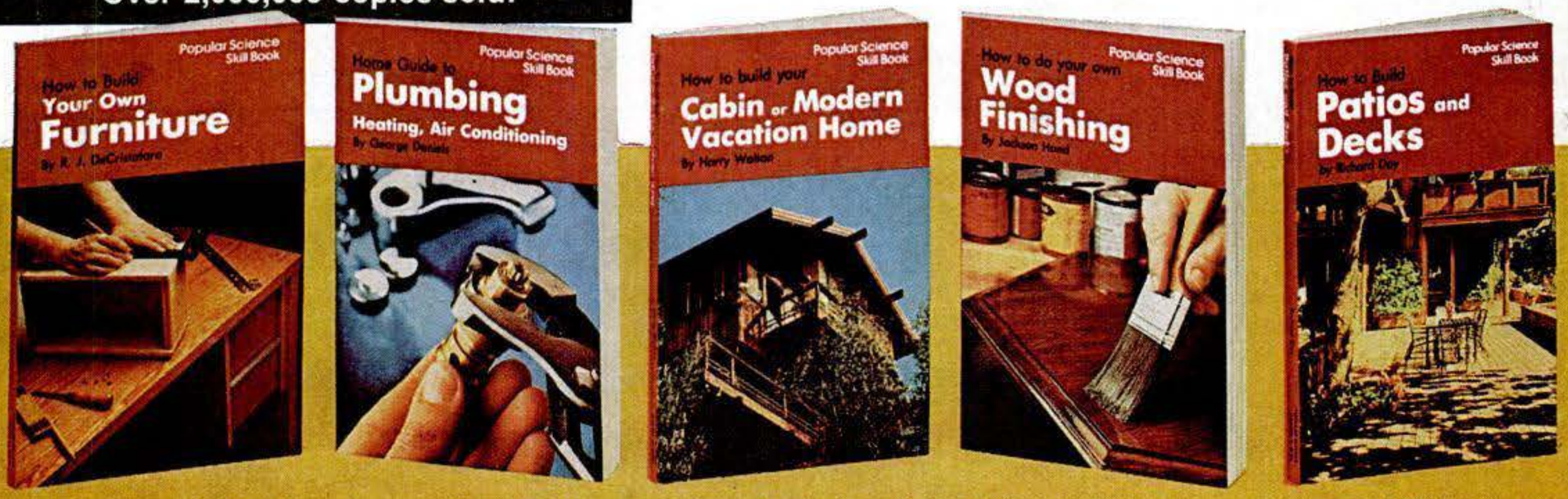

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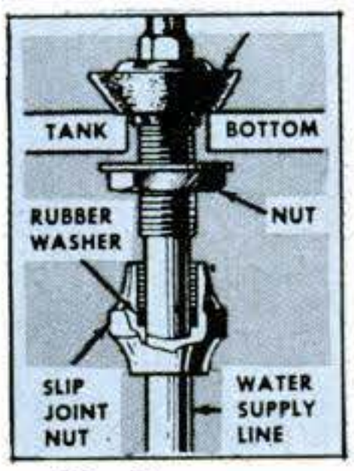

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Shop projects...

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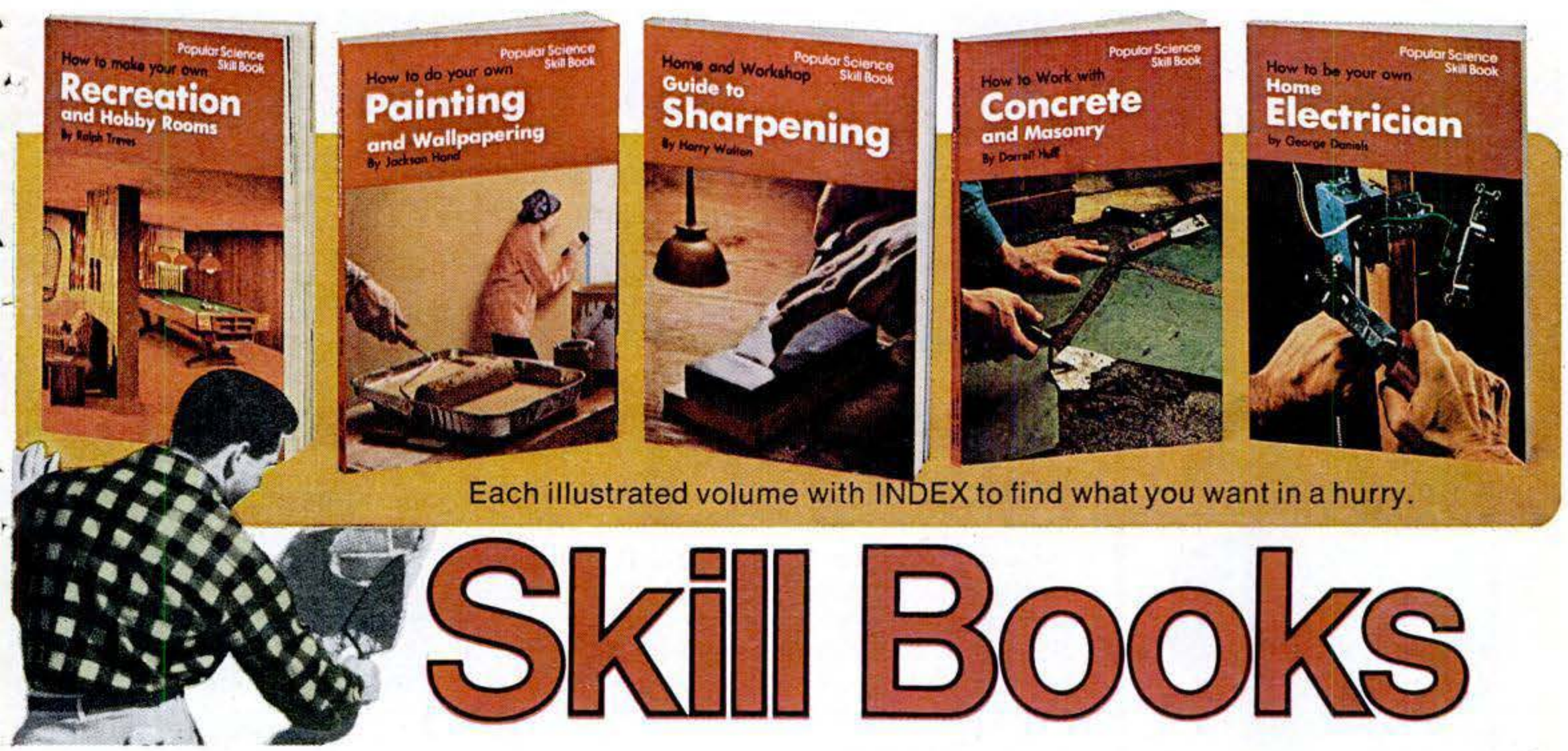

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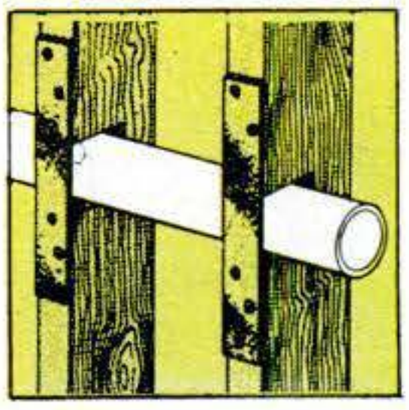

Building details...

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Steel It urethane-formula spray recoats a truck wheel fast. It's a tough, rustproof coating for lawn furniture, screens, bikes, and tools. Brush-on Steel It high-temperature formula (left) protects hot surfaces.

Steel pigment makes a tough paint

The toughest paint you can buy? That's what the manufacturer claims. And when you consider the fact that the pigment is 100-percent stainless steel, you just might agree. Steel It is a chemical coating that's been used by industry for several years, and is now available to you.

It comes in two formulas, a high-temperature type with a silicon base, and a standard formula with a urethane base. Both are available in aerosol or brush-on form and contain finely milled flakes of alloyed stainless steel. Upon application, these flakes rise to the top of the coating and overlap to form a tough protective barrier.

High-temperature type. The manufacturer recommends this type for protecting exhaust systems, barbecues, stoves, and engines. To give it a severe test, I applied it to the muffler of my garden tiller. It brushed on nicely, without the streaking you often get with aluminum paints. But it required very frequent stirring; the heavy pigment settles out fast. After waiting the required hour's drying time, I fired up the tiller. The paint discolored in some spots, but it did not burn off or flake away.

The paint blistered in some spots where I had applied it too heavily. Obviously, solvents trapped beneath the surface skin were boiling off. Moral: Give the work plenty of time to dry.

No primer is required, says Ronn Faigen, sales manager for Stainless Steel Coatings. Steel It does require a clean substrate, however, free of grease, moisture, and loose rust. A test patch I applied to a rusty truck muffler began to show signs of rust pitting after a few days' use.

Steel It urethane. The big plus for this formula is its toughness and corrosion resistance. The maker claims it will "prevent corrosion and abrasion for a minimum of eight years under severe conditions, even longer under normal conditions." That sounds optimistic to me. Even a sheet of solid stainless can wear away in less than eight years under severe conditions. In fact, when I abraded test patches of Steel It and ordinary aluminum paint with a pad of steel wool, both patches wore away in 30 seconds.

Corrosion resistance is another matter. Many makers of food-processing machinery use Steel It to protect their products; the finish should hold up for years on bikes, tools, lawn furniture, screens, and mailboxes as well.

Steel It products are made by Stainless Steel Coatings, Inc., Box H-265, Littleton, Mass. 01460. Prices? About $9.69 a quart, $5.29 a pint. The aerosols run $3.29 for a seven-ounce can of urethane, $3.59 for the high-temp. Fourteen-ounce spray cans are $5.39 for urethane, $5.98 for the high-temperature variety.—*A. J. Hand*

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[Continued from page 4]

the present cylinder and pistons. They would be placed one each to the right and left, and located, as per your schematic, where the inspection ports are now shown. The piston would then be connected to the swing beam or a direct straight link connected to the piston shown and a pivotal link connected to this connecting link.

Careful consideration leads to the following observations:

- Balance and thus vibration characteristics of the engine would be even better.
- Power-to-weight ratio will be much better.
- Bearing loads and member stresses will actually be reduced with power output doubled.
- The need for a heavy flywheel will be reduced even further.
- If needed, compression ratio can still be altered by having two pivots for the base of the swing beam, one higher and one lower.

Gerald Hewes, Jr., Mayville, N.Y.

D. W. Tryhorn replies: "If we put extra cylinders and pistons, coupled in line, to the same rockers, it would become a shuttle-piston engine, and with this type, some problems are better solved—but some become worse. The idea of the pistons bouncing off combustion pressure at both ends of the stroke is good, but:

"1) The outer cylinders become loop-scavenge, not opposed-piston, and as these would also have a fast inner dead center, they would be down in power. In fact, combustion may not start at all if, on starting, the engine raced on the o.p. power.

"2) The engine would not be a useful shape, being very wide and short.

"3) There would be quite a complicated set of passages to supply the air to all cylinders and take the exhaust away.

"4) It still does not get over the out-of-balance caused by the centrifugal force of the rockers at midstroke. To cure this, an H-shaped engine would be needed.

"I appreciate the suggestion, but still think that industry will prefer the simplest and most compact solution to their problems of reducing noise and vibration to an acceptable level—designs that don't depart too far from many accepted practices, including shape. Just think of the market for a 100-hp engine the same shape and size as a telegraph pole—no matter how good it was!"

Motorola's microprocessors

Your January issue covered a small part of the microelectronics industry, namely microprocessors. I thought Jim Schefter did an excellent job explaining the subject. However, he did not mention Motorola, Inc., as being a major contributor in the MPU market.

Motorola developed the MC6800 around the same time that Intel developed the 8080. The MC6800 microprocessor is used extensively in many commercial and industrial applications. Motorola also participates in major GM and Ford MPU programs.

Bill Altonen, Manager,
Product/Design Engineering,
Motorola Inc., Mesa, Ariz.

Paper in waterless toilets?

I was interested in your article concerning the practicality of "Waterless Toilets" [Jan.]. But there is one question I need to have answered: Can toilet paper be used in them? I am considering installing this type of toilet in my house.

Michael D. Conley, Anna Maria, Fla.

Ed Moran replies: "Toilet paper will disintegrate like any other organic matter in composting toilets. Some composter manufacturers recommend that a special paper be used in their units—available from the manufacturer, of course—but there's no reason why standard paper could not be used."

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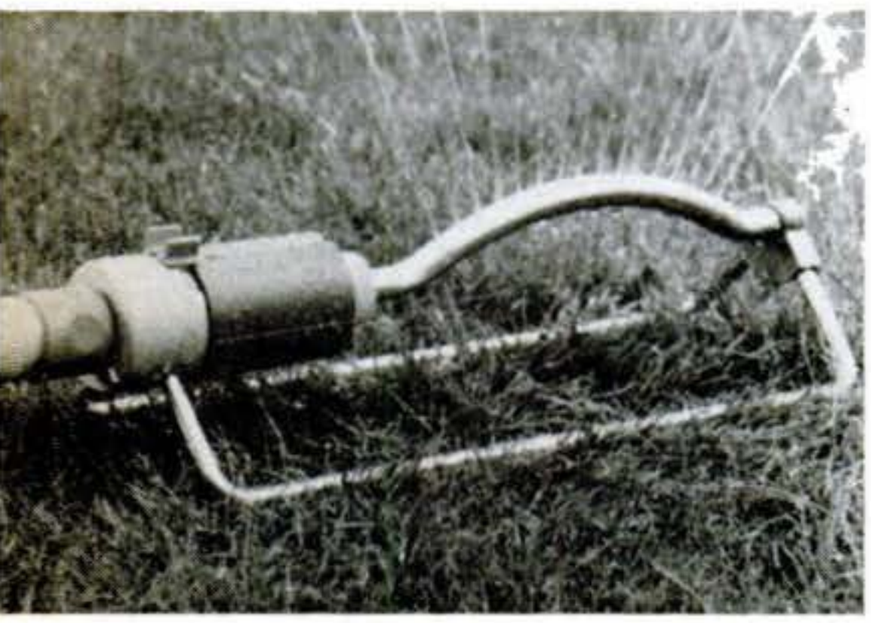
Cultivate crops with clever new garden tools

By LAURA WESSNER



Quick-disconnect Click-On system lets you hook on sprinklers (above) or spray nozzles (right) with ease. Water shuts off when you remove accessory. From Gardena, 380 Franklin Tpke., Mahwah, N.J. 07430. Two connectors: $1.99.

Turning a wheel against a vibrator on the handle of this seed scoop lets you sow one or two seeds at a time precisely where you want them, reducing waste. It adjusts for large or tiny seeds, as well as powdered or pelleted fertilizers. From W.F. Nicke, 19 Columbia Turnpike, Hudson, N.Y. 12534. $4.95 ppd.

Lightweight polyethylene Ballbarrow has a big wheel that won't get stuck in mud, maker claims. The 10-in. inflatable ball-wheel also increases stability. Deep bin carries almost 100 percent more than conventional wheelbarrows, and even hardened concrete can't adhere to its rustproof surface, says Ballbarrow Corp., 1320 Ardmore Ave., Itasca, Ill. 60143. It's $50.

Pendulum-action of the Scuffler's double-edged steel head uproots weeds faster and easier than a hoe, claims True Temper Corp., 1632 Euclid Ave., Cleveland, Ohio 44115. Price: $6.49.

For more garden tools, turn to page 154

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Now, if what all that means is a mystery to you, it's understandable. But put it all together and what it gets you is plain as day.

A saw with longer bearing life. Longer brush life. Stronger, longer lasting gear teeth. Virtually unbreakable armature connections. And higher sustained torque, smoother power transmission, quieter running.

What's even more impressive, if that's possible, is what you can see yourself.

The aluminum baseplate, upper and lower bladeguards, and gear housing. Not to mention features like a ¼" pretravel safety switch and the same sawdust-ejection chute on our best builder's saw.

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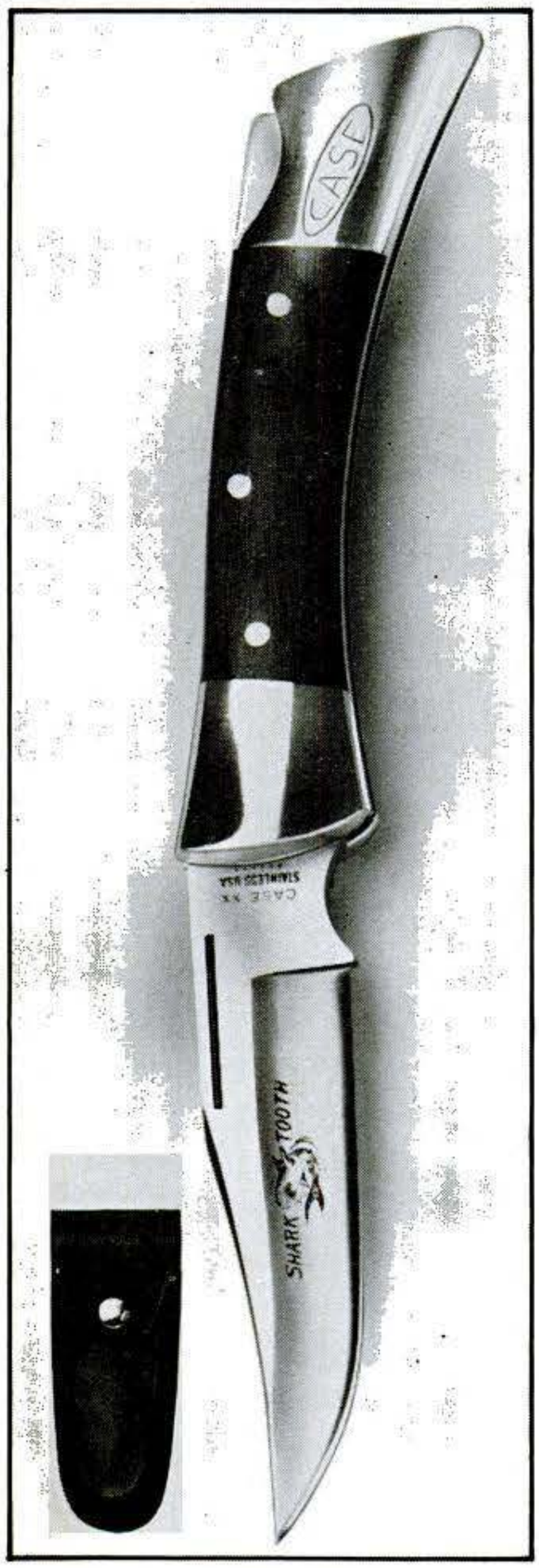
Shark Tooth



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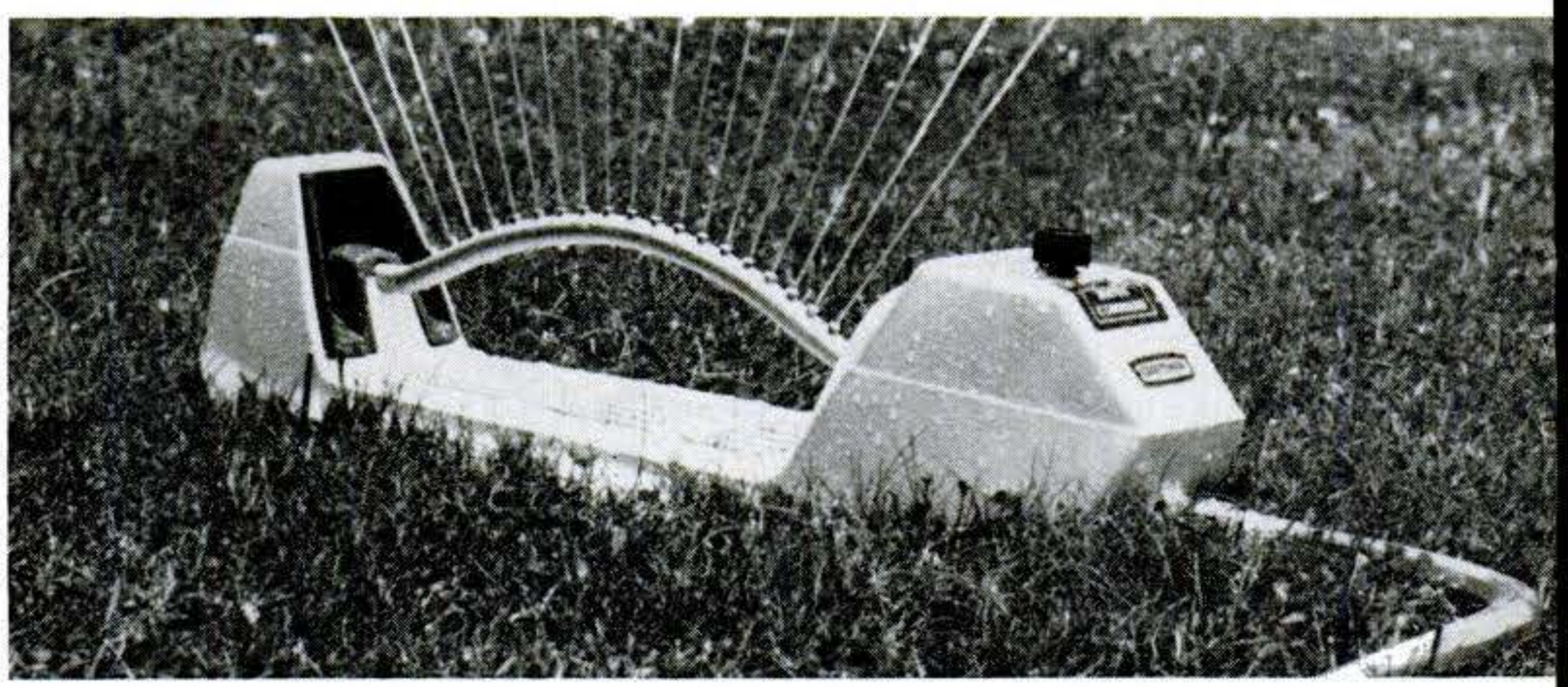
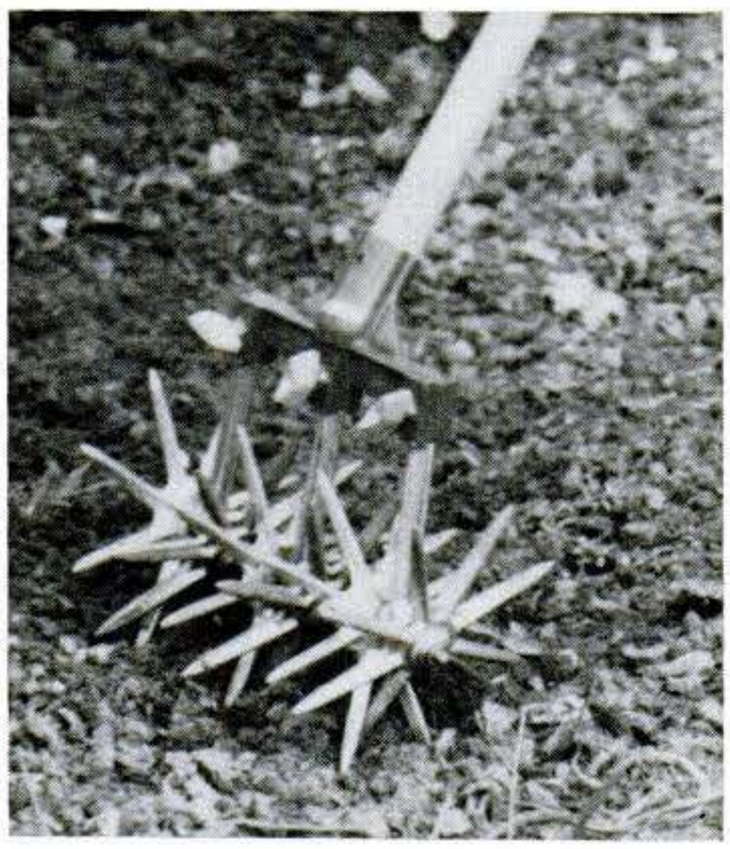
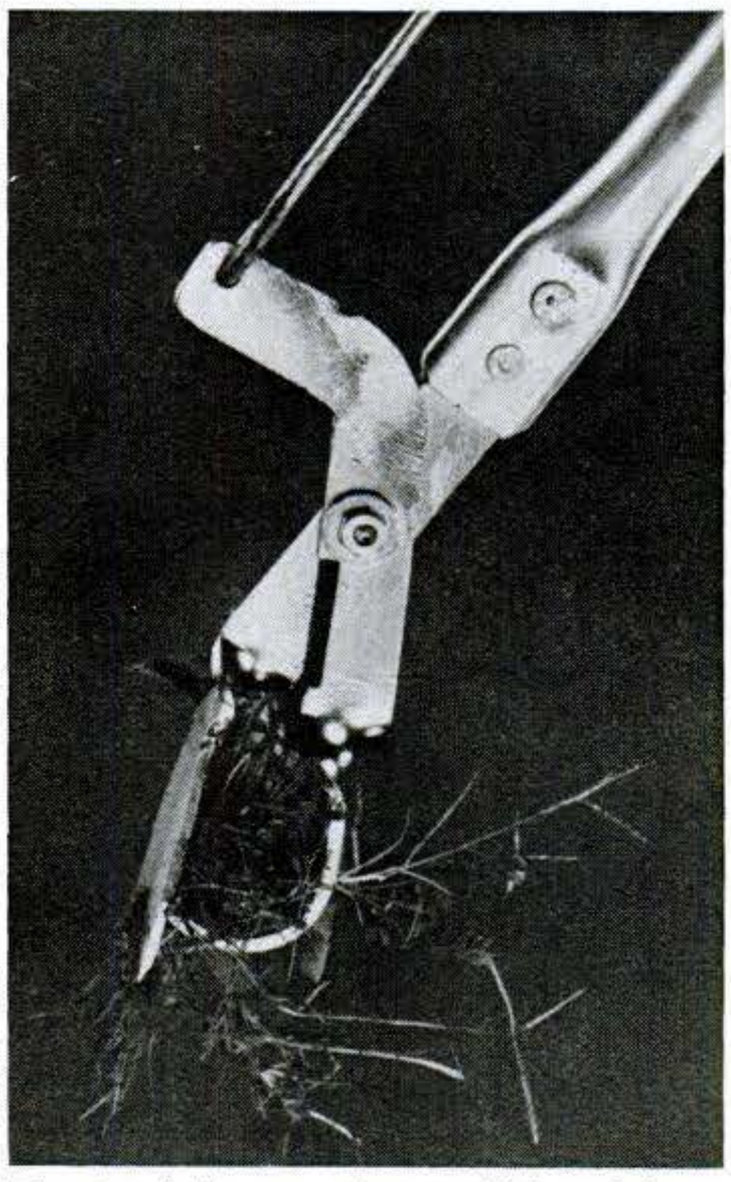


Preset the automatic timer on the Craftsman Water Command oscillating sprinkler and you get the equivalent of up to ¾-in. rainfall. It covers 3100 sq. ft. of lawn. From Sears for under $20.



The Garden Weasel's wheels rotate against each other to admit air, water, and seed into soil as it weeds. The cultivator/weeder is made by Faultless Starch/Bon Ami Co., 1025 W. 8th St., Kansas City, Mo. 64101. It's $29.95.



Two tools in one, the new lightweight metal E-Z Weeder lets you pull weeds and prune shrubs without reaching or bending. From American House, 8 Sandy St., East Northport, N.Y. 11731. Price: $12.95.

You set the Time-A-Matic oscillating sprinkler's timer for the exact amount of water needed. Timer also indicates its previous setting. Melnor Industries, One Carol Pl., Moonachie, N.J. 07074, makes it. $28.

Continued

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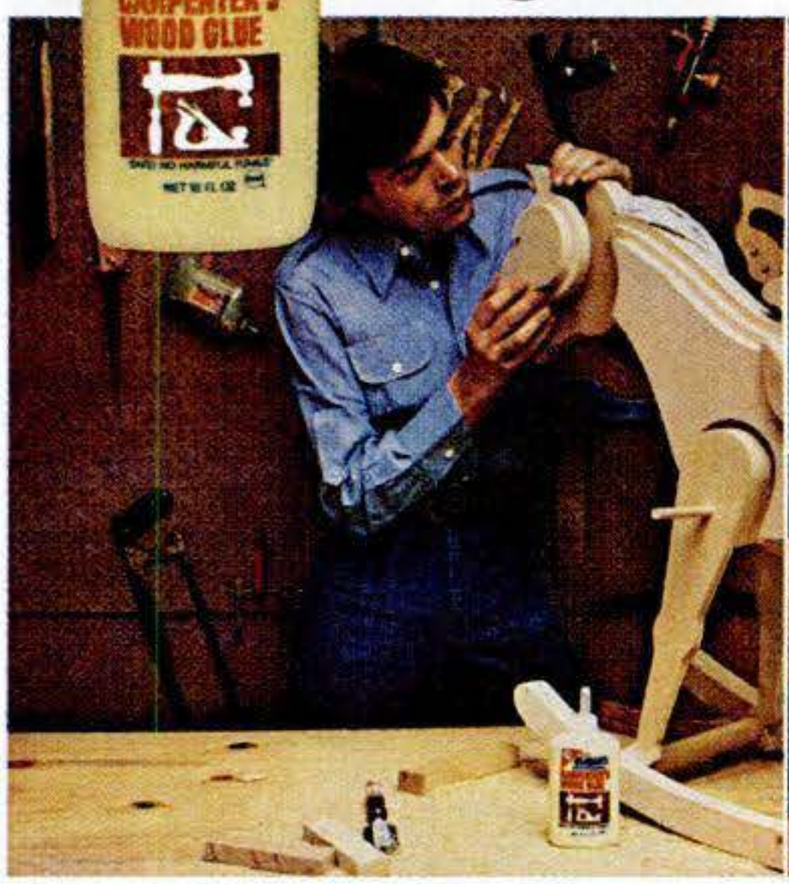
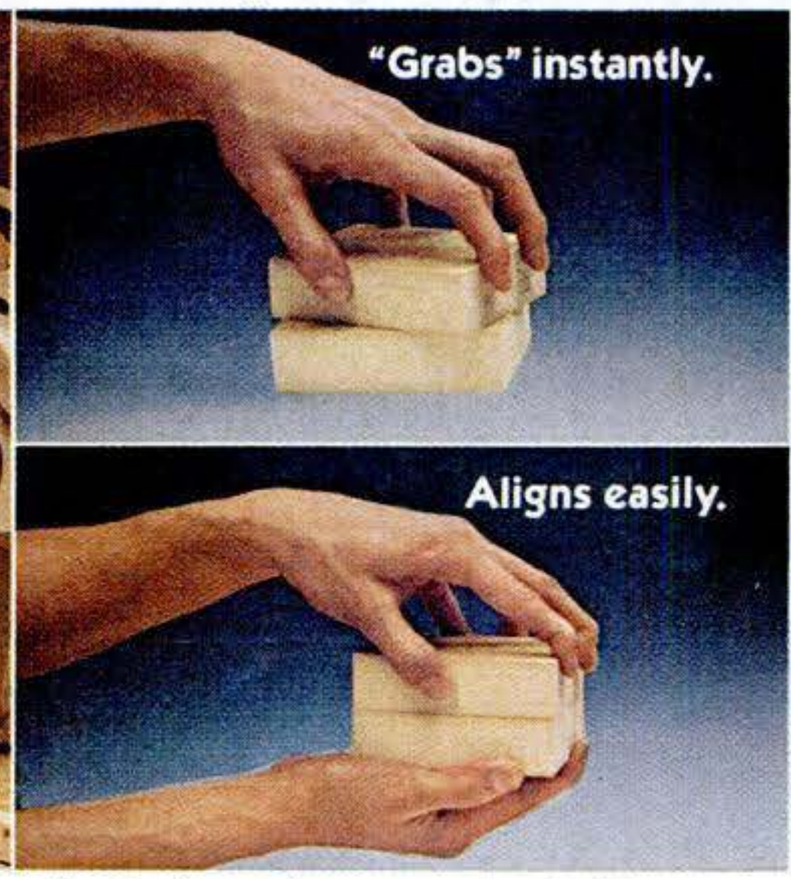
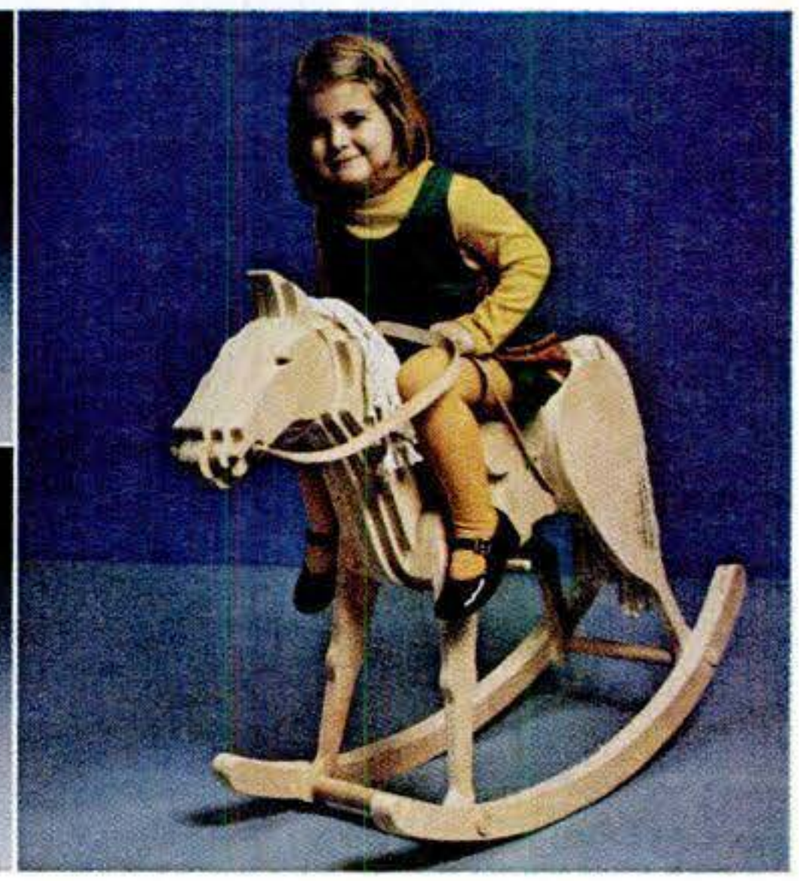
With Elmer's Carpenter's Wood Glue you don't need a pro's hands to give it the pro's touch.







Elmer's® Carpenter's Wood Glue is a special wood glue for all your woodworking projects. It penetrates well in hard and soft woods and forms a heat and water resistant bond that's stronger than the wood itself.

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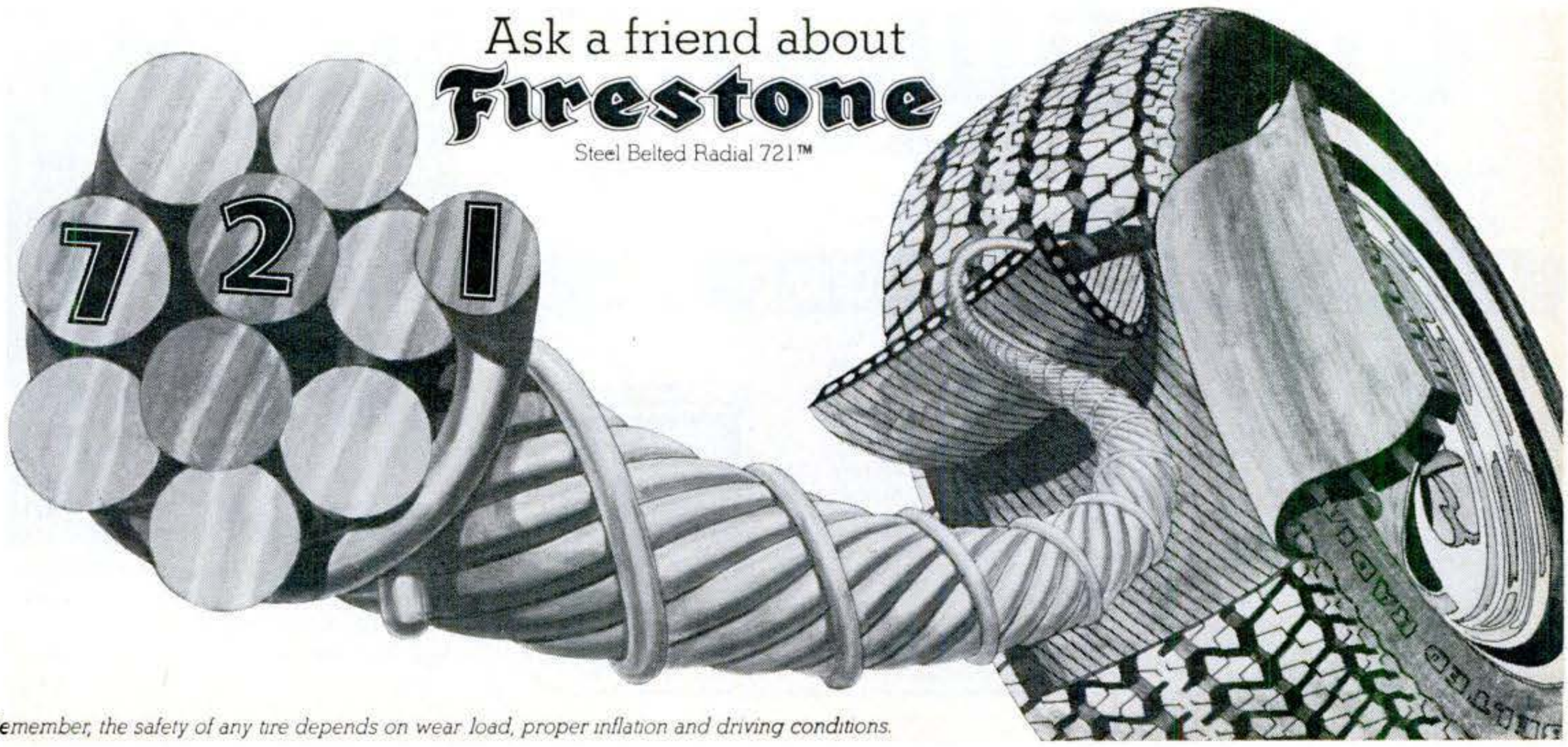

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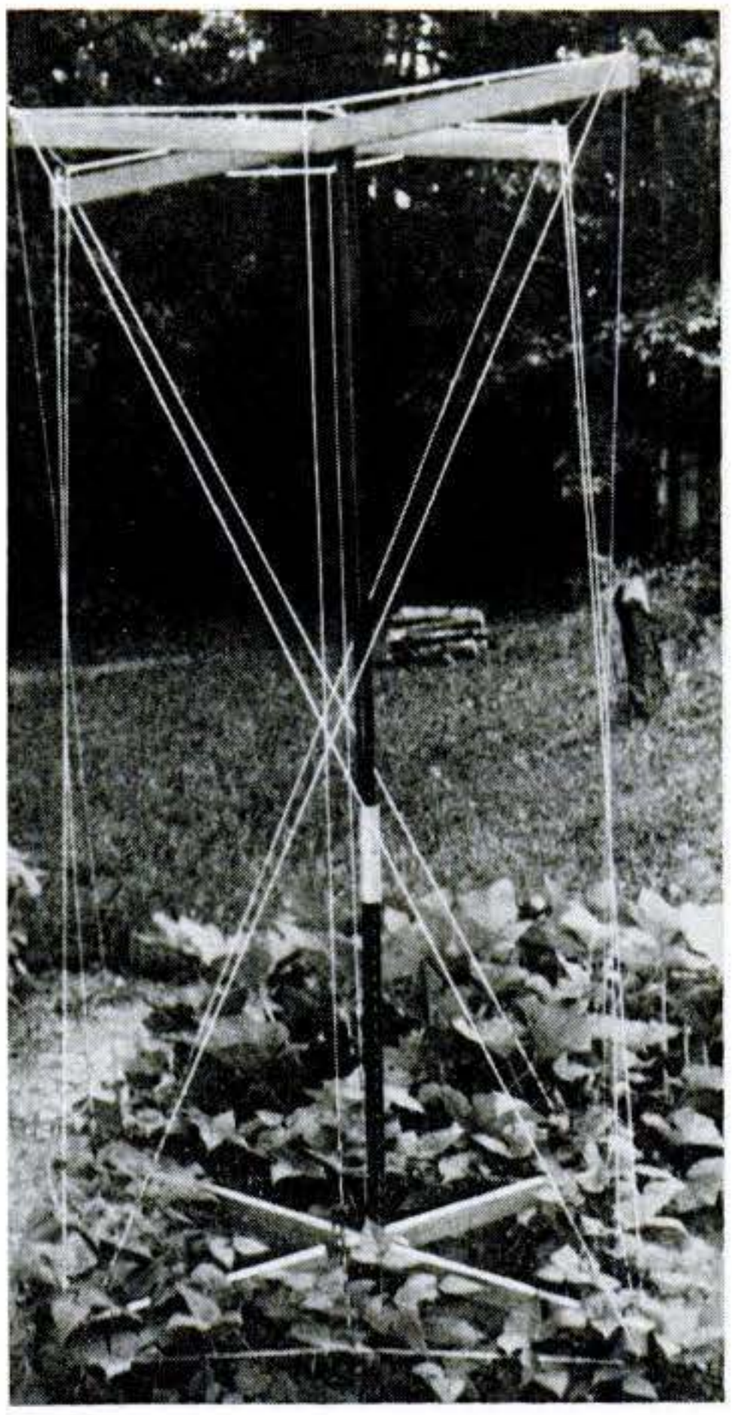

A bounty of beans could climb the three-foot-square Beantree. Its six-foot-tall fiberglass pole supports four arms laced with nylon strings for 25 linear feet of planting. Cuts weeding time and saves water. Chasco Products (Dept. 154, Box 981, Tucker, Ga. 30084) sells it for about $14.

Featherweight Craftsman aluminum shovel at three lbs. is 25 percent lighter than most steel shovels. It's made from high-strength aircraft alloy and has a one-piece construction that resists rust. Sears sells it for about $13.

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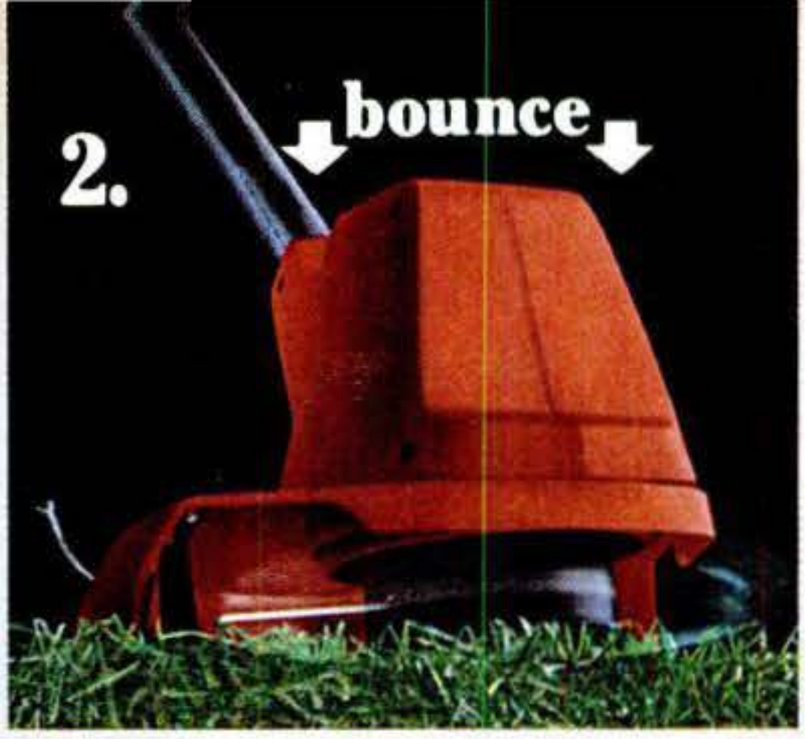

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3. ...automatically advances fresh line and cuts it to the proper trimming length.

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You avoid the three-step hassle of manual feeding.

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A few other outstanding features make this heavy-duty trimmer a worthy addition to the Toro family of quality lawn-care products.

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A comfortable ring-grip handle slides up or down to accommodate the user's reach. A telescoping tubular shaft adjusts to the user's height.

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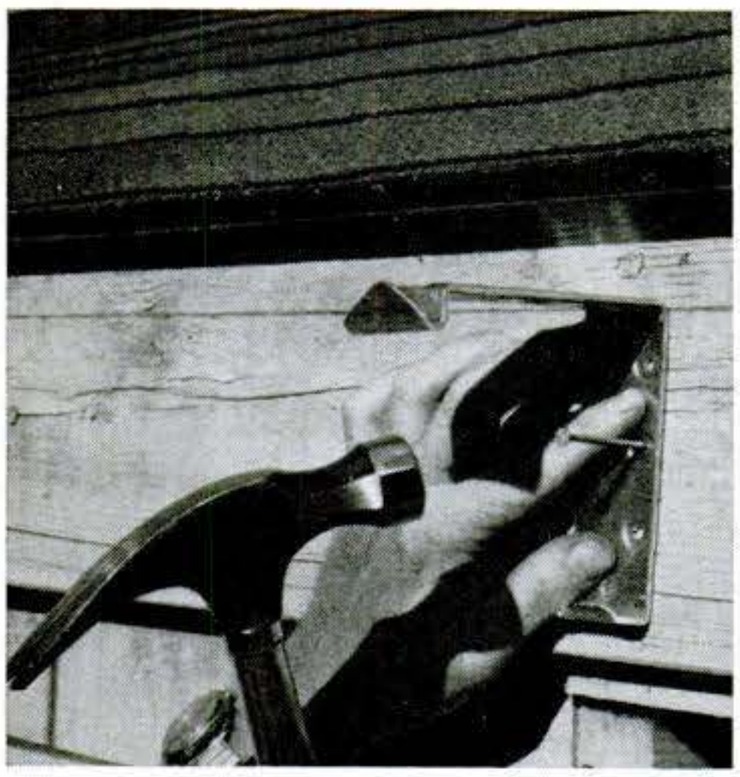
Leaky drain system? Replace it with no-maintenance vinyl guttering

Rugged, long lasting, and easy to install

By DOUG DAY

Just as metals phased out wood, vinyl may be the coming thing in home guttering. Rigid gutters and downspouts of polyvinyl chloride—the same PVC material used in many plumbing systems—are practically maintenance-free. They never need painting (although if you want to match them to your house you *can* paint them), they're corrosion-free, and they won't conduct electricity. Lean a ladder against them and vinyl gutters will bend, even flatten, then spring back to their original shape. And while they generally cost more than galvanized or aluminum, their virtual indestructibility can't be matched by either metal.



Space metal support brackets 24 inches apart—closer if there's a danger of ice buildup. Use chalk line as a guide.

A further reason for vinyl's popularity is its ease of installation. Joints are a rivet-and-cement affair, and suspending the lightweight sections on quickly installed hangers is easier than ever. Quality installation is now possible even for the beginner.

Although you may be able to find PVC guttering in half-round shapes (Vinyl Craft is one brand, made by Plastic Building Products Co., 2206 Frankfort Ave., Louisville, Ky. 40206), the most standard style is the ogee as shown in my photos. The brand we used is from Bird & Son (Washington St., East Walpole, Mass. 02032), largest maker of vinyl guttering.

Planning your layout

Installation planning is mainly a matter of determining the amount of material needed, and counting locations for accessories and downspouts. Adding up the total footage of all the roof edges to be guttered gives the needed trough material. Most guttering comes in either 10- or 20-foot sections, but a few brands are available in a wide variety of lengths. This is handy, since factory-made cuts are almost always cleaner and squarer than you could make them.

Accessories vary with the gutter system and manufacturer. Most require joint cement as well as special fittings for inside corners, outside corners, downspout outlets, and end caps. A few need snap or slip fittings at each joint, while others use a lap-joint method that eliminates the fittings. Although not needed for most jobs, an accordion-like expansion is called for by some manufacturers. This

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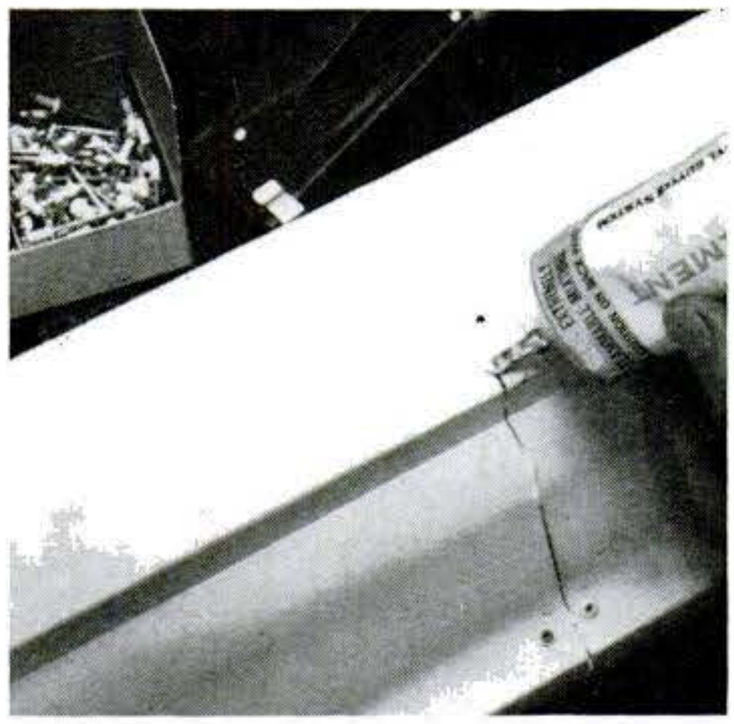
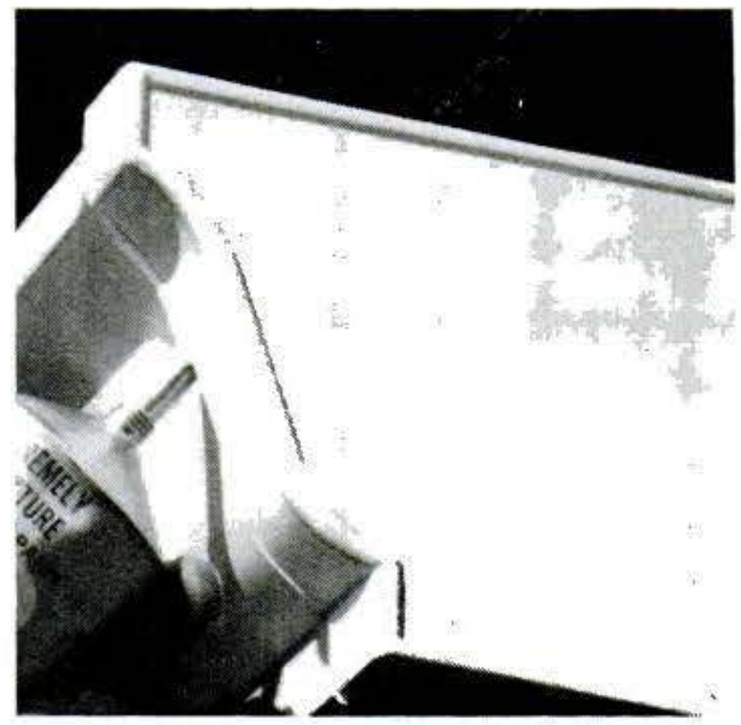


Inside connector joins two gutter sections. Pop rivets hold joint together. Seal joint, rivet heads with PVC cement.



End caps are also sealed with PVC, but gutter outlets to downspouts are not, allowing for expansion and contraction.

fits on straight runs of 40 feet or more, or where the gutter makes a complete circuit around a building.

Downspouts are the key to a gutter system. Take a bit more time to estimate how many you'll need. Too many give a gutter system a cluttered look. Too few can cause a gutter to overflow at regular intervals, defeating the whole purpose of your system.

An easy formula is to allow one downspout for every 20 feet of gutter length. Runs of less than 20 feet would need just one downspout; from 20 to 40 feet would call for two; and so on. Where the guttering goes all the way around a building, as with a hip roof, at least one downspout should be used on each wall face. The reason: Water will not flow efficiently around corners, and maintaining the proper slope at a 90-degree turn—to keep the water moving toward the next spout—is difficult.

More accurate than this method is to take into account the surface area of your roof. This is especially important for houses with complex rooflines, such as split-level homes or those with dormers. These complexities, as well as a highly peaked roof with a steep slope, will increase the roof surface area—as well as the amount of rainwater gathered—since rain seldom falls exactly vertically. Allow one downspout for every 500 square feet of surface area. Whatever figure you arrive at, though, don't go below that estimate of one downspout for every 20 feet of gutter; that's the minimum.

Planning downspout locations is the just-as-important next step. If possible, downspouts should go at corners of the building. On straight runs where three or more downspouts are called for, try to space them evenly for both practical and esthetic reasons. Of course, windows and doors may prevent precisely even positioning. Water discharging near a doorway could prove to be as hazardous as it is unpleasant.

Installing gutters

The first step in the actual installation job is to provide the gutter with a strong, protected backing. If necessary, the fascia board at the edge of the roof should be puttied, sanded, and painted, or even replaced.

Sloping of gutters is tricky. With no slope toward the outlets, draining is slow and puddling can occur. Sloped gutters, on the other hand, sometimes lend a peculiar look to a roofline. The minimum amount that a gutter should be sloped is ½ inch in 20 feet, or a 0.2 percent drop. That small slope should be hardly discernible.

Establish the slope for the troughs by starting at the high point of the run. For a roof edge with only one downspout, start at the end opposite that spout. A two-downspout edge would have the high spot in the middle, and a three-downspout edge would have two high spots. One would be between the first and second outlet, the other between the second and third outlet, like an elongated letter M.

Thumbtack a chalk line to the fascia at the high point of the run, where you want the gutter's top edge to line up. If you live in a

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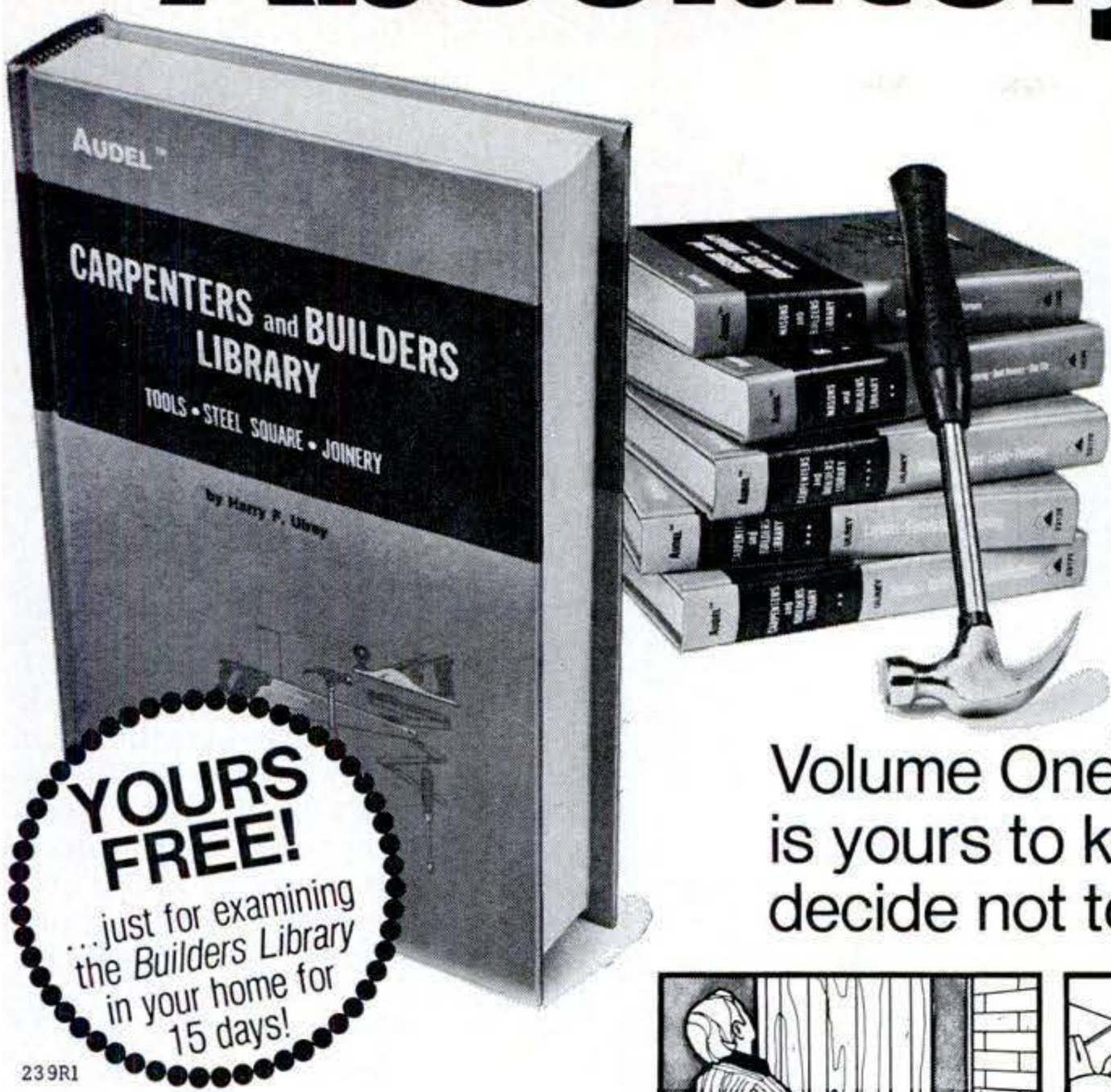

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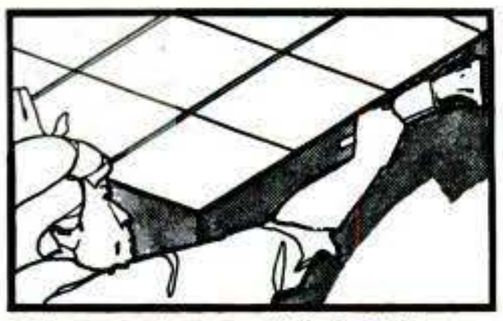
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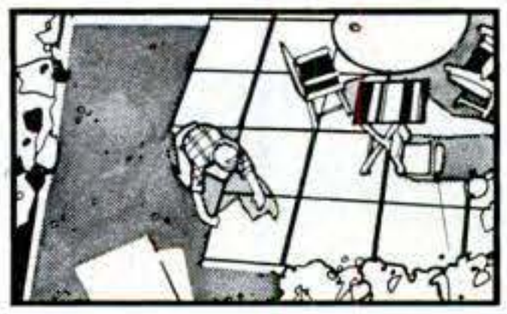
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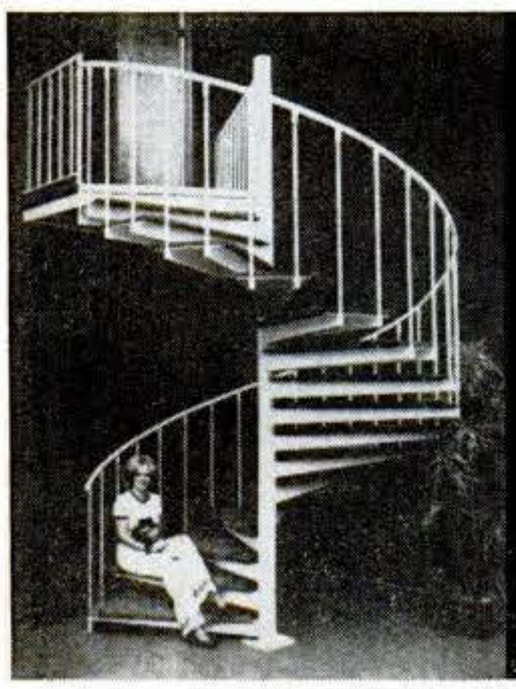

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Vinyl guttering

[*Continued*]

snowy climate, be sure that the outside edge of the gutter (the edge farthest from the roof) lies below the roofline. This will allow snow to slide off without catching the edge. Extend the line 20 feet or less, depending upon where the next downspout outlet will fall. Pull the line taut and set it perfectly horizontal, checking with a standard level or, better yet, a line level. Then drop the low end one-half inch and snap a chalk line. Do the same for all the high-to-low runs along the roof edge.

Preassembling the pieces

Some manufacturers recommend doing all assembly and joint work in the gutter's finished position—on the roof. Their reason is that a more accurate fit of downspout outlets, corners, and other fittings can be achieved that way. But the hassle of connecting pieces from the top of a ladder could be avoided by measuring carefully, then assembling on the ground. Sample-fit downspout outlets in the locations you've chosen, then make a mark on either side of the outlet on the fascia. Measure precisely up to the outlet mark and, if necessary, cut the gutter section to fit. By working in 20-foot sections on the ground—any more than that will be hard to handle—you'll have a minimum number of joints to make after the section is raised.

Most gutters come with special snap or slip couplings that are used to make joints, either from one trough section to another, or from a trough to a fitting. The coupling and the gutter itself are buttered with cement, then the two are snapped or slipped together. Slip joints have a reputation for leaking. Heat, or even the normal hardening process, can cause the gutter cement to shrink. The result can be an opened joint and often a leak. Snap connectors can also leak and are sometimes hard to work with. An alternate method that is sometimes easier and often better is the lap-joint method. A lap joint is made by merely overlapping one section of gutter two inches over the other, like shingles on a roof. Cement and rivets are used to attach the pieces.

One caution with lap joints, though: Be sure that the joined section closer to the downspout outlet—the lower section—laps *under* the other. That way the moving

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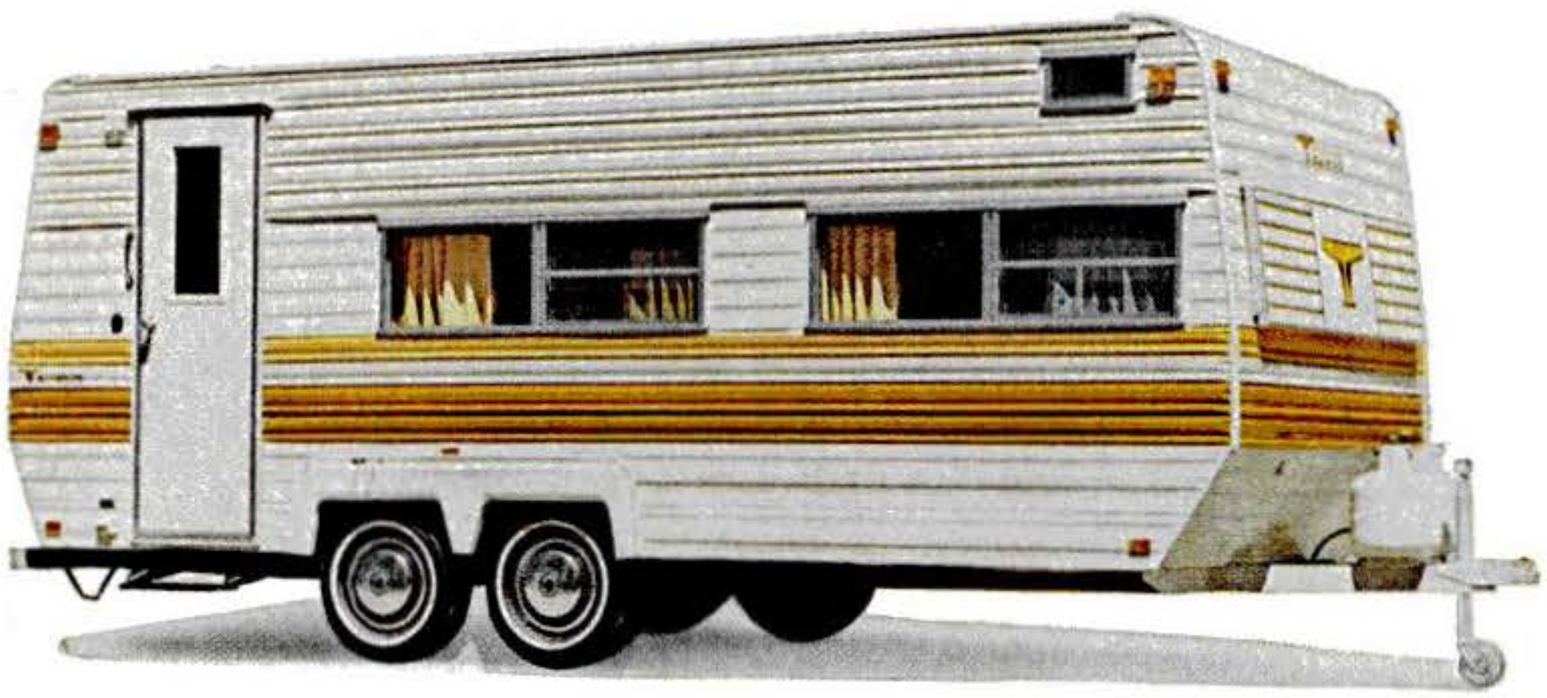

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Vinyl guttering

[*Continued*]

water can't force its way into the joint. Also, of course, add two inches to the dimensions to allow for the overlap.

To accommodate all the various gutter types, hangers come in all shapes and sizes. Align the top of the hanger with the chalk line you snapped earlier, spacing additional hangers about 24 inches apart. Be sure to provide added support at downspout locations; one on each side of the outlet should be enough.

Fitting the downspout

This is the last step. If your roof has an overhang, attach a downspout elbow directly onto the outlet, then another elbow so the spout will fit flush against the house. If it falls short of the house, add a small length of spout between the elbows.

Downspout sections are larger at one end than the other so they can be fitted together. Always be sure that the larger end goes at the top, so that water will not escape at the junction. Downspout joints should be cemented. To hold the spouts snugly against the house, use a couple of the special straps.

At the bottom of the downspout add another elbow to direct the water away from the house. A concrete splash block will further discourage water from creeping down a foundation wall. Or try one of the coil-up water dispersers that roll up neatly during dry periods, then unroll with the water pressure and sprinkle over a wide area.

For a top-notch gutter installation, or where rainfall can be extremely heavy and erosion becomes a real problem, install an underground dry well. This is merely a hole dug into the ground and filled with rocks or old concrete blocks and bricks. Gutter water is then carried below grade and is absorbed into the soil.

One final touch completes the installation. Add the cone-like strainers to the top of downspout outlets to eliminate the clogging and overflowing that can occur when sticks and leaves work their way into the chute. It is also a good idea to install an aluminum or plastic mesh, available in roll form, over the top of the troughs. This will eliminate the annual drudgery of scooping out the debris that can short-circuit a gutter system's intended purpose. In combination with a vinyl system, this mesh guard will all but allow you to forget about your gutters. PS

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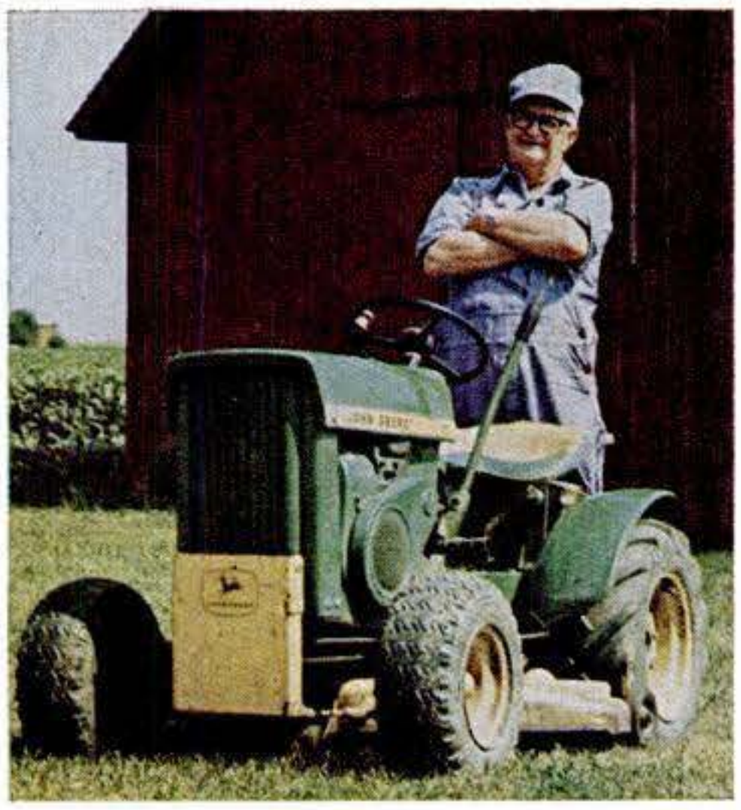
"You'd have to whip me to get this tractor away from me."

Bill Hendrickson, Arthur, Illinois



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SHOP TALK

By AL LEES

HI dozen for summer projects

I've saved comment on the above accumulation of books until this month's home-improvement issue because the one thing they have in common is a dedication to the proposition that today's homeowner ought to be more than a mere maintenance man. You shouldn't hesitate to tackle projects that will upgrade your home and enrich your lifestyle. All you're likely to need is professional encouragement, accurate and thorough instruction, and a realistic expectation of what your skills and persistence can accomplish. Do these books offer all this?

Let's start the appraisal with a trio of books, at upper left, on masonry. (We have room, this month, to tackle only the back row. In May's Shop Talk we'll review the balance and list publishers' addresses.)

● *Concrete, Masonry and Brickwork* ($4, Dover) is a big-format paperback of 200 pages, subtitled *A Practical Handbook for the Home Owner and Small Builder.* It also has my favorite byline: "By the U.S. Dept. of the Army." It's a wonder the how-to writers of America don't sue, for Dover has simply republished, without alteration, the Army's technical manual, *Concrete and Masonry.* Since federal publications are usually quite good, the text here is accurate and the drawings clear—if you don't mind the training-manual organization and the fact that much of the data is for field engineers. You have to dig for basic tips on concrete, but there are good instructions for building forms and for laying block. Still, this is lazy bookmaking.

● *The Brick Book* ($12.95, Crowell) might be subject to a similar charge, since it's a pickup of a British book by London architect Robert Hayward. Some months ago, when Crowell asked me to evaluate the imported galleys, I pointed out a number of discrepancies between British terms and dimensions and ours; most of these have been adjusted, but Hayward's project sketches are still peppered with such unfamiliarities as "centre" and "hardcore" (it's crushed rock to you, Yank—not porn). What I hadn't been shown earlier were the striking, original designs (in photos and sketches) of specific projects—from patio paving and planters to carports and gazebos—that make up the last half of this 192-page book. They'll keep you busy.

● *Concrete and Masonry Techniques and Design* ($14, Reston) is yet another recent book of instruction from PS Consulting Editor R. J. De Cristoforo; he's produced so many, for different publishers, in the past couple of years, that I forgot this one while commenting on his latest books in February's Shop Talk. This one's so thorough it's used as a text in vocational schools—which explains those brief quizzes at the end of each chapter (with answers at the back of the book). With typical thoroughness, Cris covers all aspects of mixing, pouring, and finishing concrete, and laying block and brick. But he doesn't stop with general techniques: He gets specific about tools and jigs and forms you can make, and details you can work into project designs. As Cris brightly con-

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cludes his otherwise-pedestrian preface: "There isn't much fun in learning to drive if you can't go anyplace." Two small complaints: Cris should have been more precise about mix proportions for specific projects (the DIYer wants to know when a 1:2:3 mix is the right one). And Reston should have let him check their index (inept listings waste a reader's time). One glaring omission in both of these books that feature "Masonry" in their title: There's no data on stonework.

Next right in our photo is a pair of unusual big-format paperbacks on carpentry. I'd recommend you buy both of them if you plan a major construction project this summer—such as adding a wing to your home or building a detached garage.

- *The Carpenter's Manifesto* ($7.95, Holt) is a big, 317-page paperback with over 600 sketches (no photos) and not one word of jargon. In their introduction, authors Jeffrey Ehrlich and Marc Mannheimer promise: "You don't have to have a shop to build anything in this book," then go on to give as concise an analysis of structural principles as I've seen anywhere. Project designs are offered for demonstration rather than esthetics, and occasionally they err in an effort to oversimplify (a machine bolt is *not* a carriage bolt with a wrenchable head). But most of their data on materials and tools (hand and power) is eminently trustable.
- *Basic Construction Techniques for Houses and Small Buildings, Simply Explained* ($5, Dover) is another government reprint from lazy Dover, which obviously felt it shouldn't show favoritism to the Army so turned to the Navy for this training manual. Interestingly, you'll find some of the same illustrations, here, as in that Army reprint above since this manual goes beyond carpentry to cover *all* construction techniques—including masonry. You'll even find such helpful homeowner's tips as how to build a breakwater/jetty or steel bulkhead. Of the 568 pages, many are of value only to career Seabees.

Moving on to the right, there's a pair of nostalgic books that also bear a faint odor of misrepresentation in their packaging. As with the Dover manuals, these are unaltered reprints in a new guise. Strip off those modern color-photo jackets, however, and you'll find honest facsimile reproductions of books first published in the 1880's. Surprisingly, they still offer practical help on country matters a century later—and the many engravings couldn't be more charming.

- *Fences, Gates and Bridges* ($5.95, Stephen Greene) is particularly welcome since there's no contemporary equivalent. "Farm fencing seems not to have altered greatly," as the new publisher says in his foreword. If you're seeking Early American authenticity for your grounds, this book will provide you with an effective fence or gate (the section on bridges is skimpier—perhaps because fewer readers had such need, even then). Back with *Barns* in May. PS

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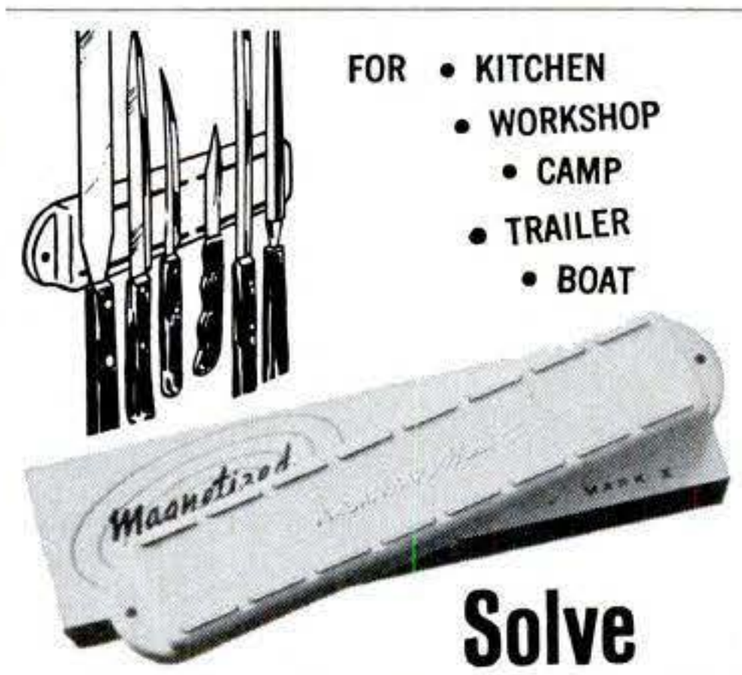

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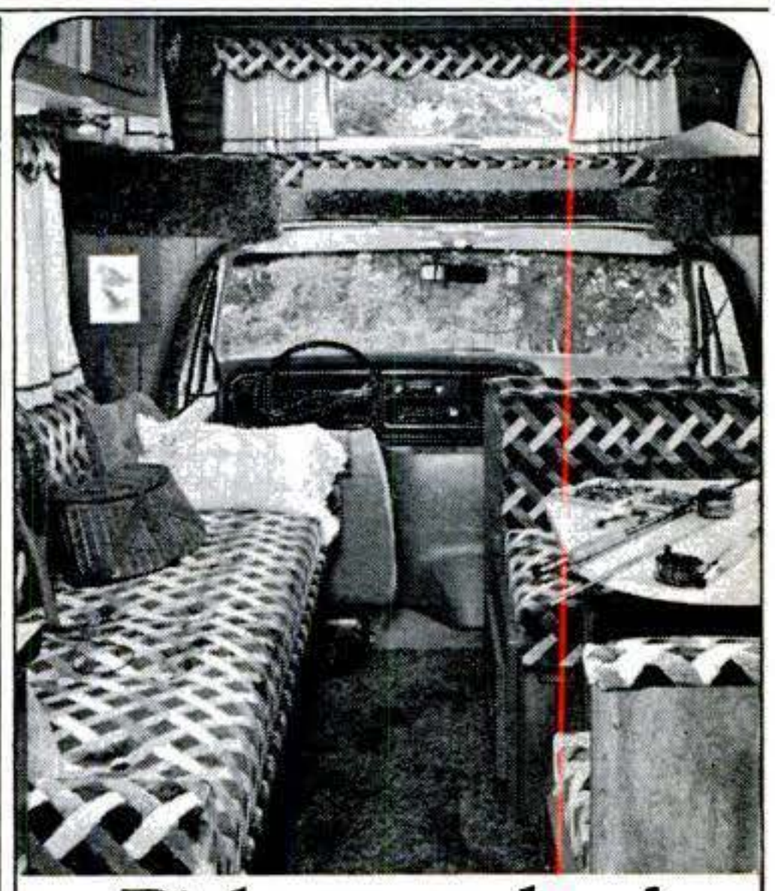

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DAY
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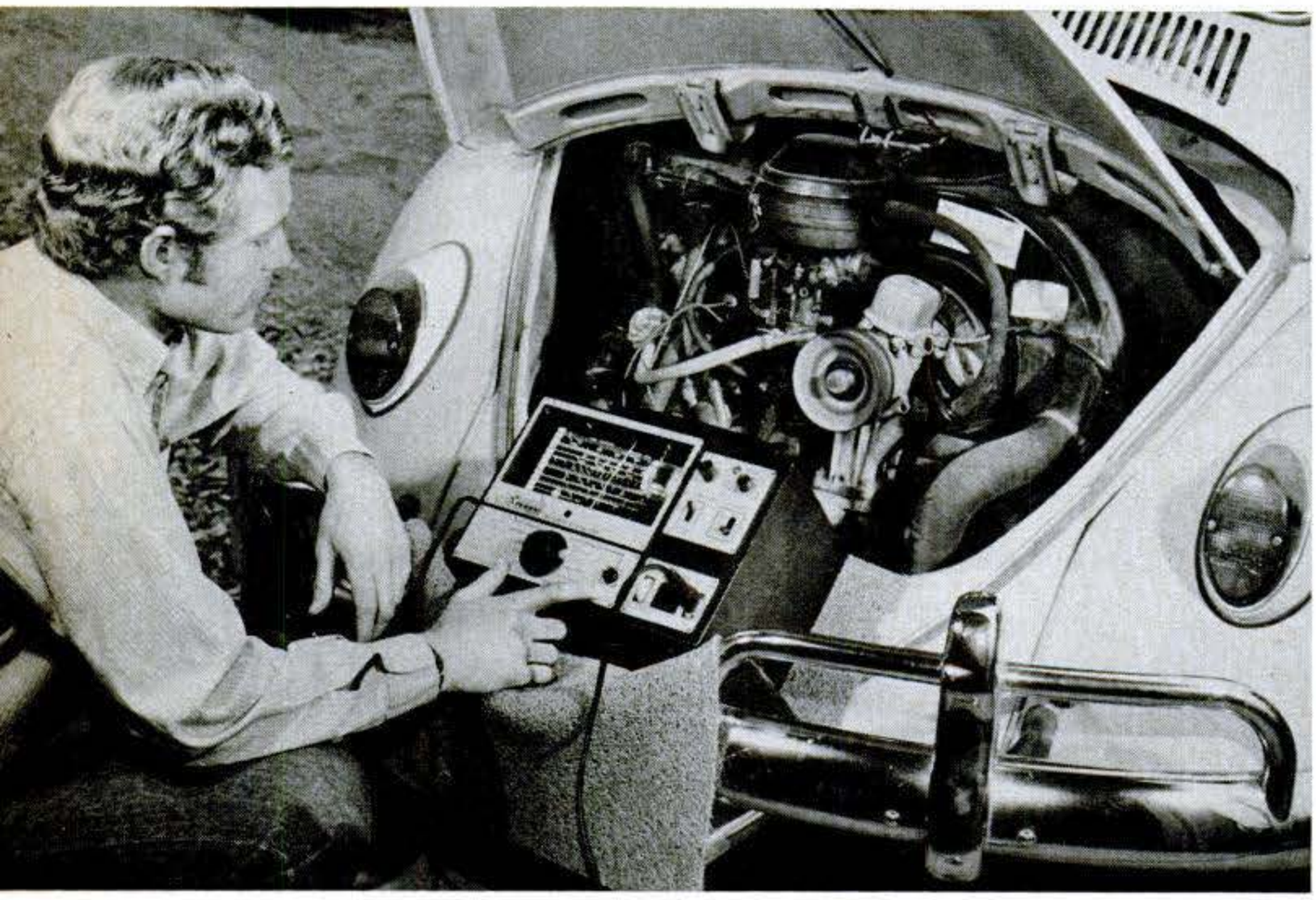
This is the first of a series. Month by month, through 1978, a photo-demonstration article by Richard Day, author of How to Service and Repair Your Own Car, *will alternate with a "Car-Care Quiz" like the one in last month's issue.*

Getting the most from an engine analyzer



By RICHARD DAY

Ever wonder whether those "do-it-all" automotive analyzers are worth the money? Are they really useful—or just gadgets to get your DIY dollars? Oh sure, the pros use them, but they have a lot of knowledge as well as other equipment to fall back on. How about us home mechanics?

To satisfy my curiosity, I bought one for almost $150. With that price tag it would have to be a lifetime investment, I figured. Although you can get cheaper models, I was afraid these didn't fairly represent what can be done with an analyzer. The cheaper units don't handle as many tests as the top-line jobs.

"Performs over 30 ignition and electrical tests," is the claim made

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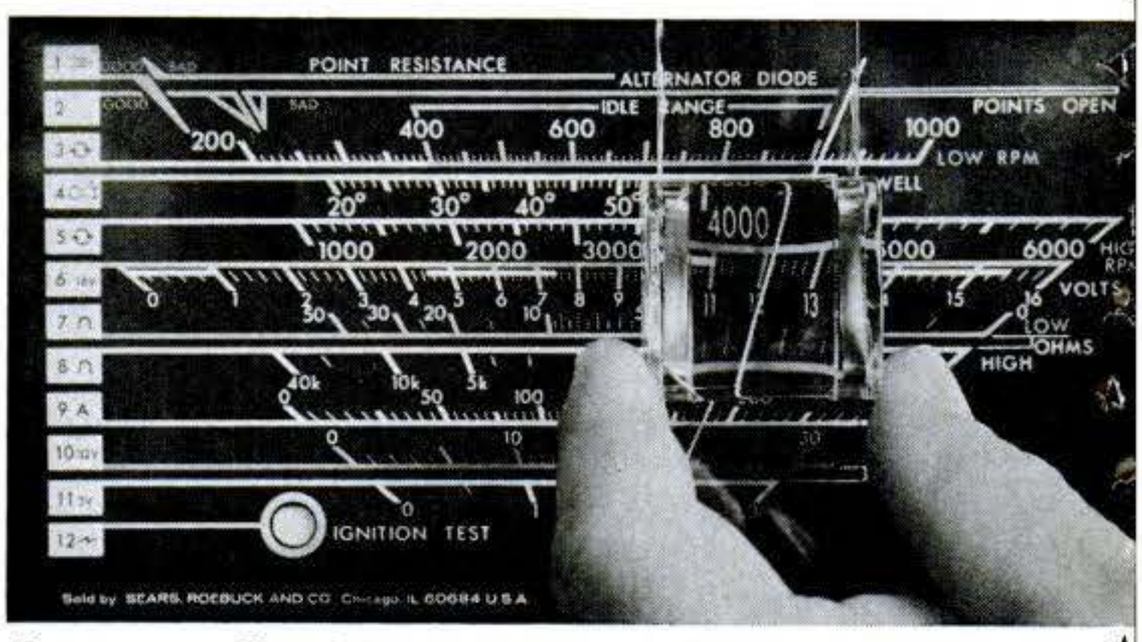

Four-way adjustable magnifier on the front of the illuminated d'Arsonval meter permits close readings. The meter's 12 color-coded scales correspond to the 12 points of the selector dial, so you always know which scale the results will appear on.

Sears Automotive Analyzer comes with several leads to increase versatility. Unit's 12-volt power-supply lead is draped over the carrying handle.

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38 / 25
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AS SHOWN

Horizon's mileage figures are very comforting too—38 mpg highway, 25 city. Of course, these are EPA estimates with manual transmission and your mileage may vary according to your driving habits, the condition of your car and its optional equipment. California mileage is lower.

Horizon is also a shining example of value. It's base priced at just $3706.* Which includes AM radio, whitewall radial tires, inside hood release along with rack and pinion steering, front disc brakes, front-wheel drive, and much more.

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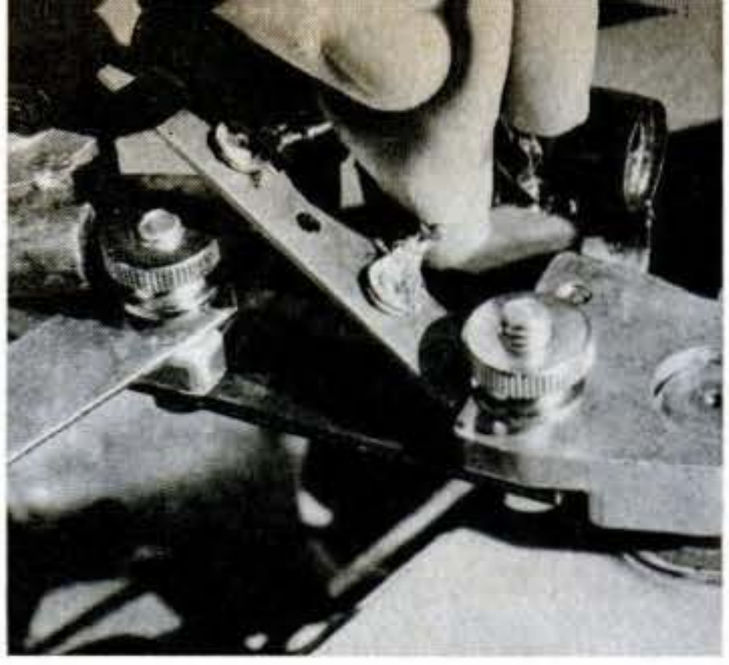


With the knife switch open and the ammeter shunt lead installed on the battery-post adapter, ammeter readings may be taken. For charging amps, the forked end of the shunt should face the negative battery cable. For opposite-flow starter-draw tests the forked end should face the negative battery terminal. Shunted current passes through the known shunt resistance while the meter reads voltage drop across the shunt as amperes. Knife switch is closed during engine startup.

Battery-post adapter with built-in ¼-ohm resistor fastens to the negative terminal of the battery for making charging-system and starter-draw tests. With the negative cable connected to the adapter's post, the engine may be started normally when the adapter knife switch is closed. When open, charging current passes through the ¼-ohm resistance, which simulates charging into a fully charged battery for accurate charging-system readings.

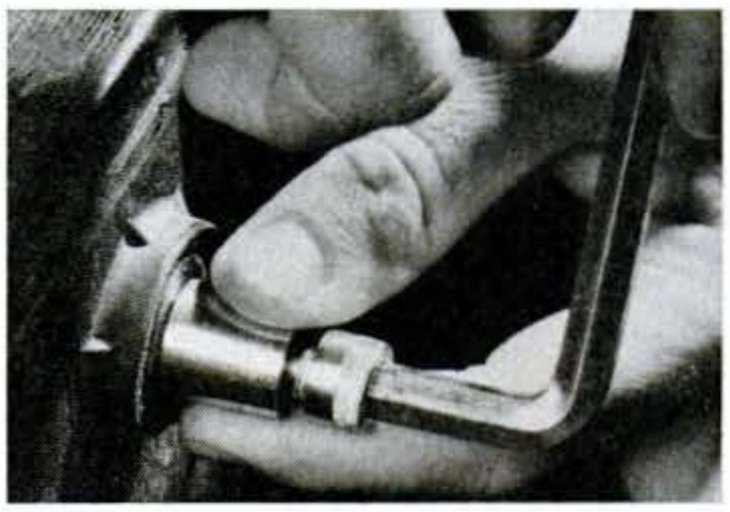
for the one I bought, the Sears "Penske" Automotive Analyzer Model 244.21043. It also makes tests on electronic ignition systems, a claim not made by some others.

Sears is underselling it, I soon discovered. The unit will make more than 40 separate tests (see list). The Sears store salesman also was underselling. He kept warning me, "If you have any trouble with it, be sure to bring it back to our service department and they'll fix it up right away." "Trouble?" I wondered, but went through with the purchase anyway.

What I received was a large plastic box containing a sensitive seven-inch-wide d'Arsonval meter with several different sets of test leads for connecting it to car electricals. It proved to be a dwell tachometer, plus a voltmeter, plus

Continued

Starter-current draw can be read on the large meter through the windshield of the car as you work the starter switch from inside. Ground the coil high-voltage cable so engine won't start. Selector and test switch should be in the "amps" position. Normal reading is between 125-250 amps, depending on engine size and tightness. Too-low reading indicates high starter resistance, if other starter circuits are okay. Too high? Short circuits in starter or its wiring.



Battery-post adapter comes with its own special terminal for hookup to a recessed battery terminal using an Allen-head bolt. The adapter is then connected to the add-on post and the negative cable is clamped to the battery-post adapter, just as with a battery with terminals protruding from the top. A word of caution: Avoid making sparks around a charging battery, and wear eye protection. Never smoke a cigarette when working around a battery, either.

A quick diode test can be made by pressing the "alternator diode" test button. Red test lead is connected to battery's negative post, black lead to other end of battery-post adapter. Selector switch is in "alternator diode" position. With engine running at at least 1200 rpm and knife switch open, put headlights on to load the system. Reading in the green band is okay. A red-band reading indicates further checking, for shorted or open diodes, or bad stator winding.

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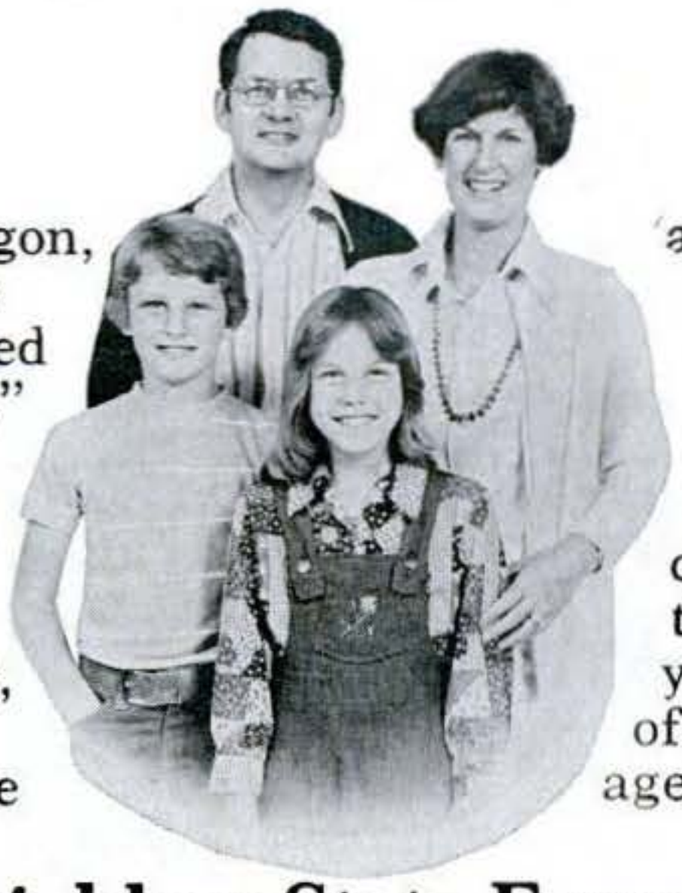
Ken Clark is four of the best insurance agents you'll ever find.



Ken Clark of Roseburg, Oregon, was Don and Vicki Cooper's homeowners agent. "We liked the way Ken took care of us," says Don. "He really works for you, and he's right there when you need him."

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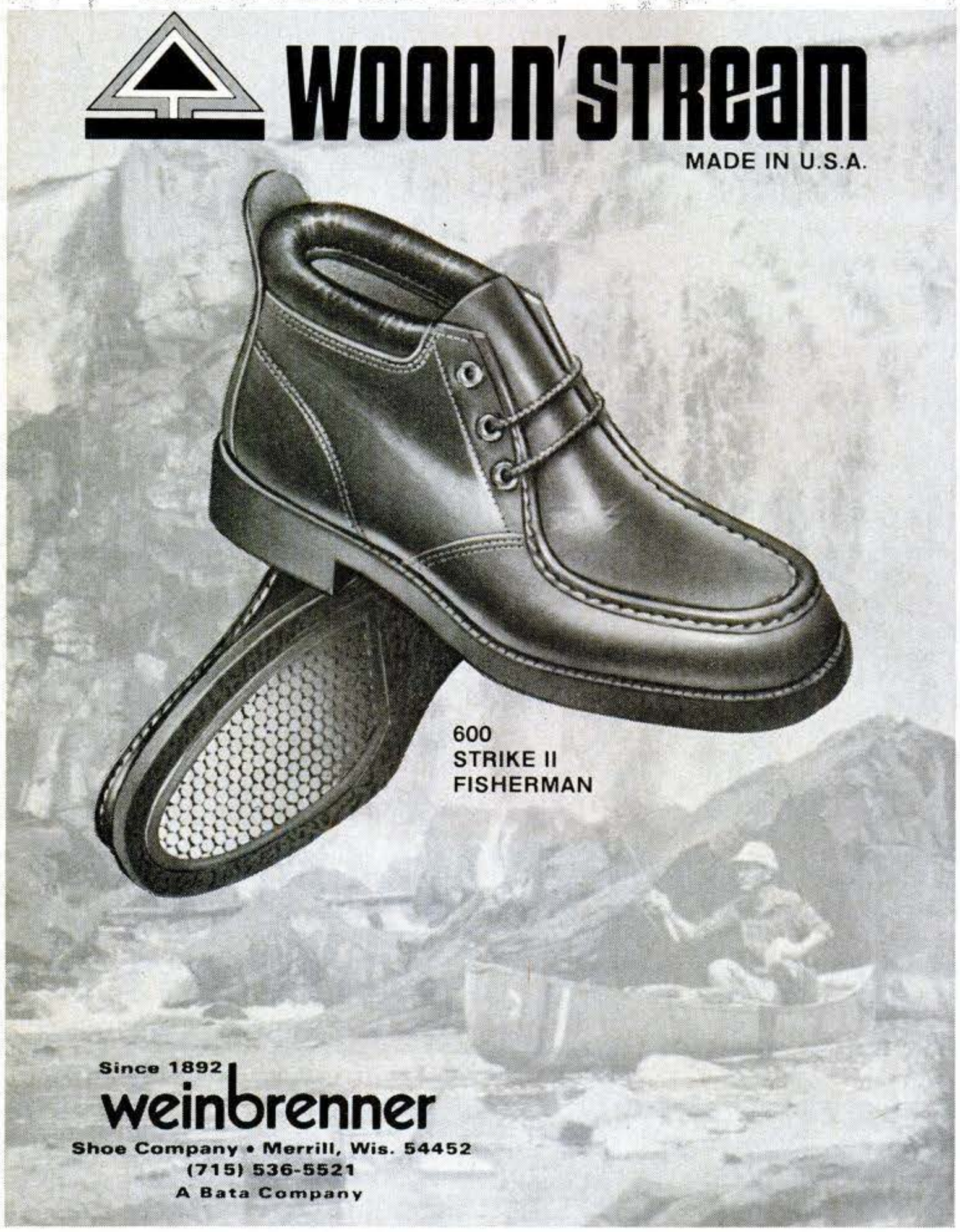

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Engine analyzer

[*Continued*]

an ohmmeter, plus an ammeter, plus a few other things. A rotating selector, like the channel selector on a TV or CB radio, switches among varying functions: (1) distributor resistance, (2) alternator diodes, (3) low rpm, (4) dwell, (5) high rpm, (6) 16 volts, (7) low ohms, (8) high ohms, (9) amps 10) 32 volts, (11) 3 volts and (12) ignition test. The numbers link with numbered scales on the meter, giving instant recognition.

Solid-state wired, the analyzer works on four-, six-, and eight-cylinder piston- and rotary-engine vehicles with 12-volt coventional or breakerless ignition systems and generator or alternator charging systems. A compartment in the back of the analyzer case holds accessories in self-storage: some handy hookup leads as well as the usual instruction manual.

The Sears manual is one of the clearest, best organized I've seen. It not only tells you how to make test hookups and perform each of the covered tests, but it also interprets test results for you. You needn't be a mechanic or even know much about cars to get results. What's more, the tests are arranged in logical sequence from hookup to hookup, from simple to complex, from most probable to least probable trouble.

Drawings show each hookup at a glance. Every warning is there, repeated if necessary from a previous test so it's hard to go wrong. You can go wrong, however, when you think you're too smart to need the instructions. Overconfident, I switched the selector around from "ignition test" to "high rpm." To get there it went through the "low ohms" position. As it did, the poor d'Arsonval pegged on the right side angrily. Were the unit not resistor-protected against such stupidity, I'd have been searching out the Sears service department.

Sure enough, in the instructions was an unmissable warning: "NOTE—Do not place the selector

Continued

WHO MAKES AND SELLS ANALYZERS?

Aside from the Sears unit we tested, engine analyzers are sold by **Montgomery Ward** and these manufacturers: **Heath Co.,** Benton Harbor MI 49022 (assemble-yourself kit); **Kal-Equip Co.,** Box 188, Ostego MI 49087; **Proto Tool Co.,** 2209 Santa Fe Ave., Los Angeles CA 90054; **Rite Autotronics Corp.,** 3485 La Cienega Blvd., Los Angeles CA 90016; **Stewart-Warner Corp.,** 1826 Diversey Pkwy., Chicago IL 60614; **Sun Electric Corp.,** Consumer Prod. Div., 6323 N. Avondale Ave., Chicago IL 60631; **J. C. Whitney,** P.O. Box 8410, Chicago IL.

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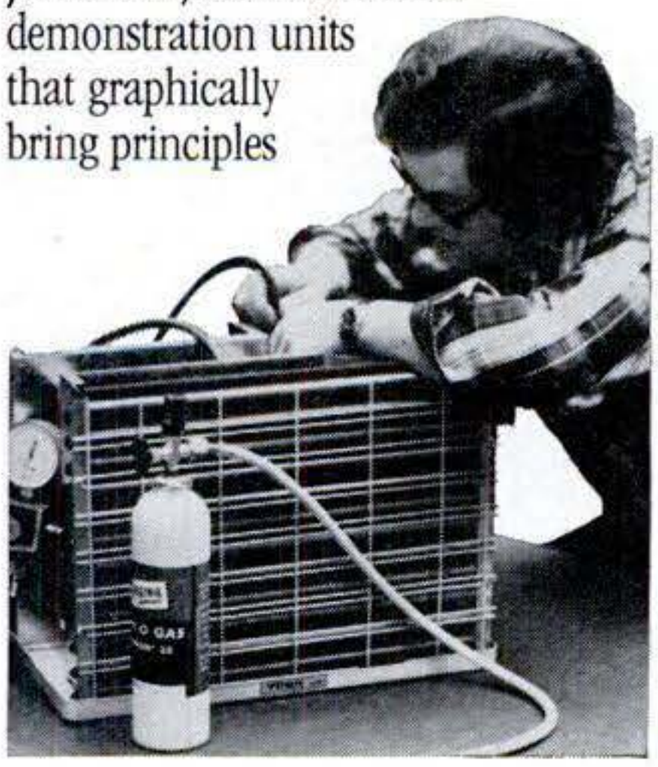

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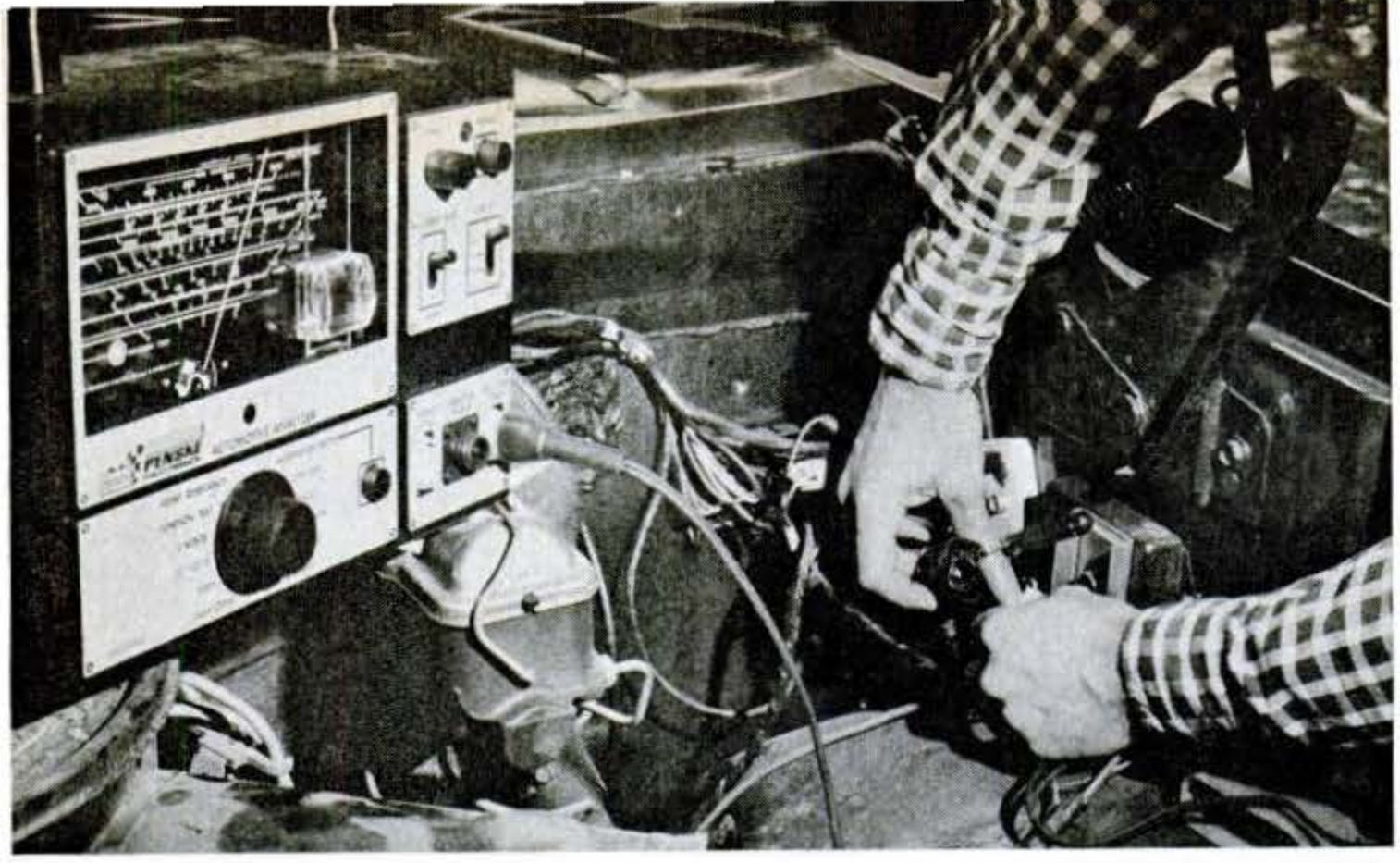
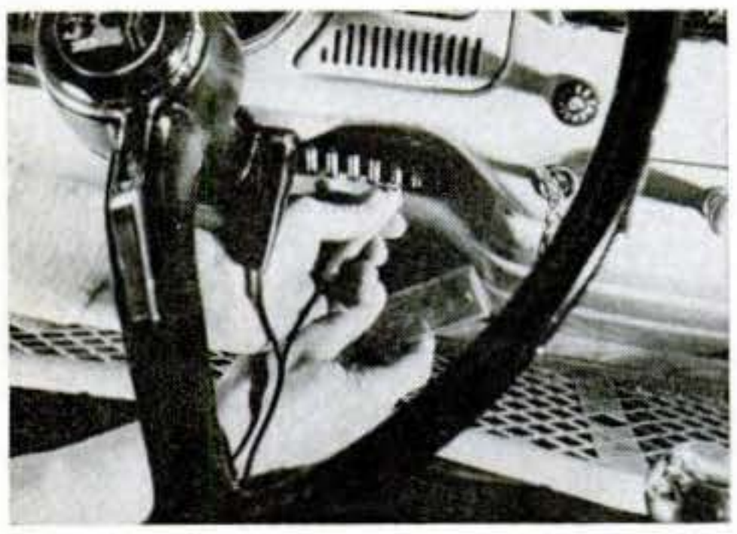
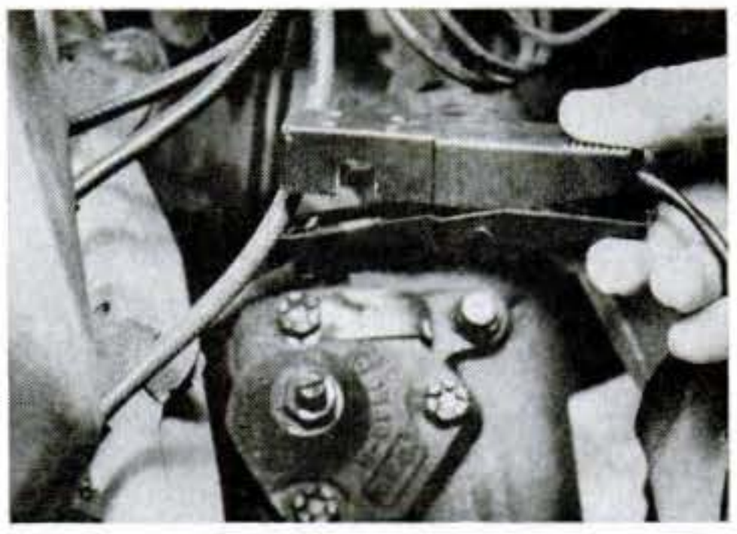


Analyzer makes many tests on electronic-ignition systems. Ohm test is made with wiring harness connector of this '78 Dodge snapped apart and a small screwdriver pushed into one of the numbered openings. A whole series of such easy tests checks out both the pickup coil and the electronic control unit. Manual gives instructions for complete ignition checkout of Ford, GM, and AMC.

Shorted condenser can be located fast with analyzer's selector in the "high ohms" position. Do it by touching red/black clips across the condenser's body, with condenser lead disconnected. A good condenser will deflect the meter very slightly to the right as the first clip is attached to the pigtail, then return to the left as the other clip makes contact with the condenser body.



Fuse continuity is quickly checked with the analyzer in the "16 volts" position. Ignition switch should be on, and the black test clip connected to a good ground. Red clip is then touched to each end of the suspect fuse. No reading at either end indicates an open circuit between battery and fuse. Battery voltage on one side of the fuse and no voltage on the other means a bad fuse.



To check ignition power or operate the analyzer's tachometer circuitry, snap the inductive pickup clamp over a convenient spark-plug cable. Once clamped on with its arrow pointing in the direction of the plug, it stays on during the tests. Analyzer's red and black leads go to battery's positive and negative posts, respectively, no matter which post is grounded to the car.

Analyzer's ignition test serves about the same purpose as holding a spark-plug cable terminal 5/16 inch from an engine ground and cranking or running the engine to watch the spark. Analyzer shows up primary and secondary ignition-system problems, as well as defective resistor spark plugs, but it does not pinpoint the problem, except as to which cylinder (or all of them) is affected.

Engine analyzer

[*Continued*]

switch in 'low ohms' position when red and black leads are connected to the battery."

Fortunately my ego was more damaged than the analyzer. Sears had thought to tape a spare resistor inside the back of the meter case. It had only to be soldered in place of the one I'd blown, and I was back in business. That was a free reminder; next time it will cost.

The accompanying photos show some of the tests you can make with an automotive analyzer, plus a few features of the Sears model. Regrettably, not all possible tests are illustrated in the manual. For example, a coil polarity test—an important one—is not shown.

To make this test you set the selector to the "32 volts" position. Connect the red test clip to an engine ground (red is correct in this case). Expose a spark-plug terminal by inserting a partially unbent paper clip into the cable's boot and coiling the opposite end around the plug's terminal. With the engine idling, touch the black test clip quickly on and off the plug terminal. If the analyzer reads up scale (to the right), coil polarity is correct. If the needle tries to sink below zero (to the left), polarity is reversed. To correct, interchange the two coil primary leads. PS

Analyzer tests you can make

Distributor-point resistance
Dwell angle
Dwell variation
Engine idle speed
Engine high rpm
Regulated charging voltage
Regulated charging amperage
Maximum charging amperage
Charging-system insulated-circuit voltage drop (resistance)
Charging-system ground-circuit voltage drop (resistance)
On-car alternator diodes, shorted or open
Individual diode bench test
Generator cutout relay operation
Battery voltage
Battery capacity
Battery external leakage
Engine-ground-circuit voltage drop (resistance)
Starter-circuit voltage drop (resistance)
Starter-ground-circuit voltage drop (resistance)
Starter current draw
Ignition spark adequacy
Ignition-coil primary resistance
Ignition-coil secondary resistance
Ignition-coil ground insulation
Ignition bypass circuit
Condenser
Distributor voltage drop (resistance)
Distributor shorts and opens
Distributor cap/rotor ground insulation
Resistor spark-plug resistance
Magnetic pickup-coil or sensor resistance
Magnetic pickup-coil ground insulation
Dual-ballast resistor resistance
Electronic-control-unit condition (on some cars by inference)
Electronic-ignition feed-wire continuity
Wiring continuity
Car ground continuity
Horn operating voltage
Wiring voltage drop (resistance)
Accessory current draw and leakage
Car ground-circuit voltage drop (resistance)
Instrument-circuit voltage-regulator action
Fuse and bulb condition

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The plain and simple fact of the matter is this: helping cars last is Quaker State Motor Oil's only job. And now, Quaker State filters can help, too.

For over 60 years, people have trusted Quaker State. And for very good reasons.

Quaker State DeLuxe, Super Blend and HD are made from Pennsylvania Grade Crude Oil. Then formulated and blended by lubrication specialists, dedicated to producing quality automotive oils for your car.

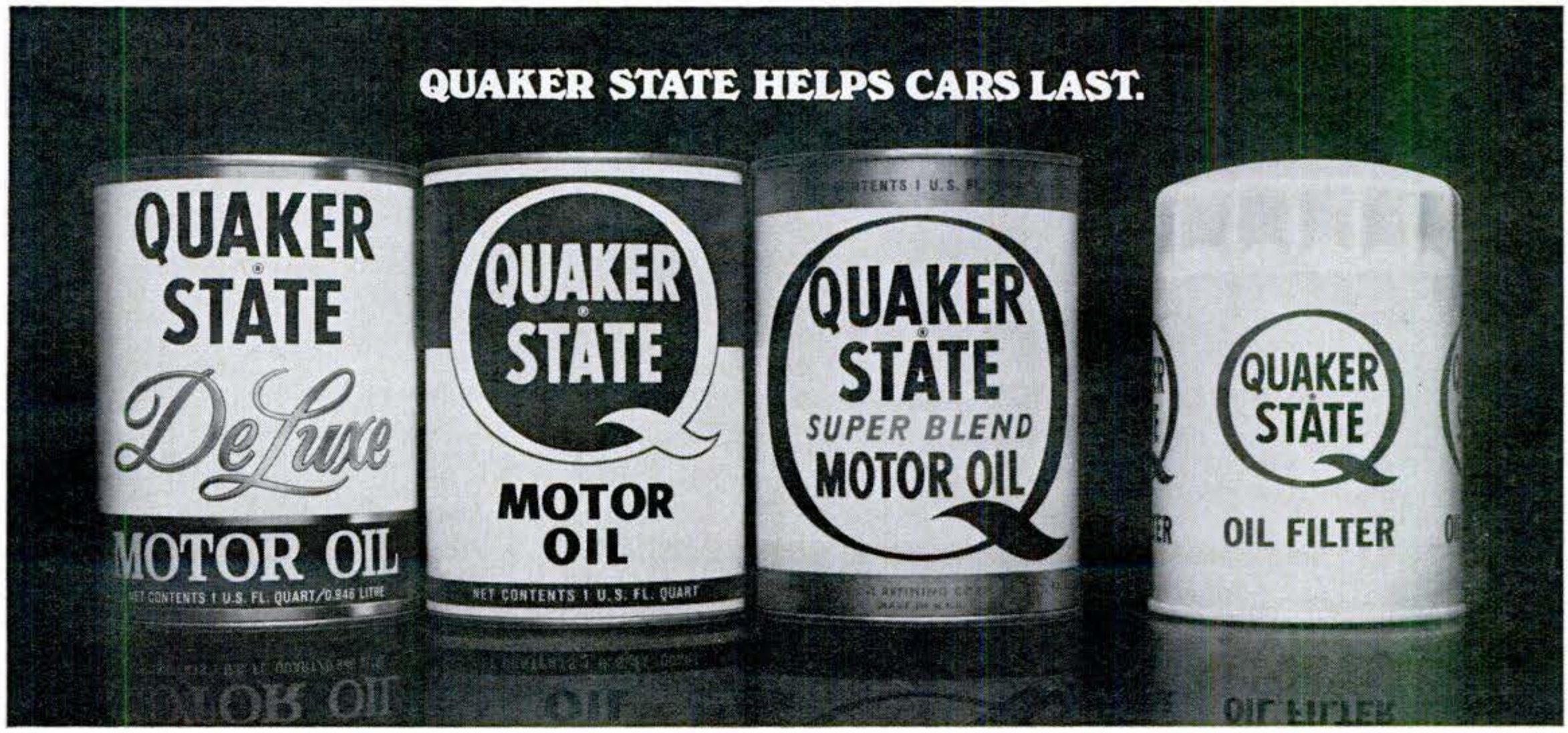
By the time Quaker State is poured into your car's crankcase, it's passed strict quality control standards. To make sure your car gets the protection it needs.

The result? If you use Quaker State regularly, you can help avoid expensive engine repairs.

Quaker State didn't get to be the best-selling motor oil in America for nothing. Quaker State means quality and value. Quart after quart after quart.

Look for Quaker State Motor Oil and Filters wherever they care about cars. Because Quaker State helps cars last.

And to car owners these days, nothing's more important than that.



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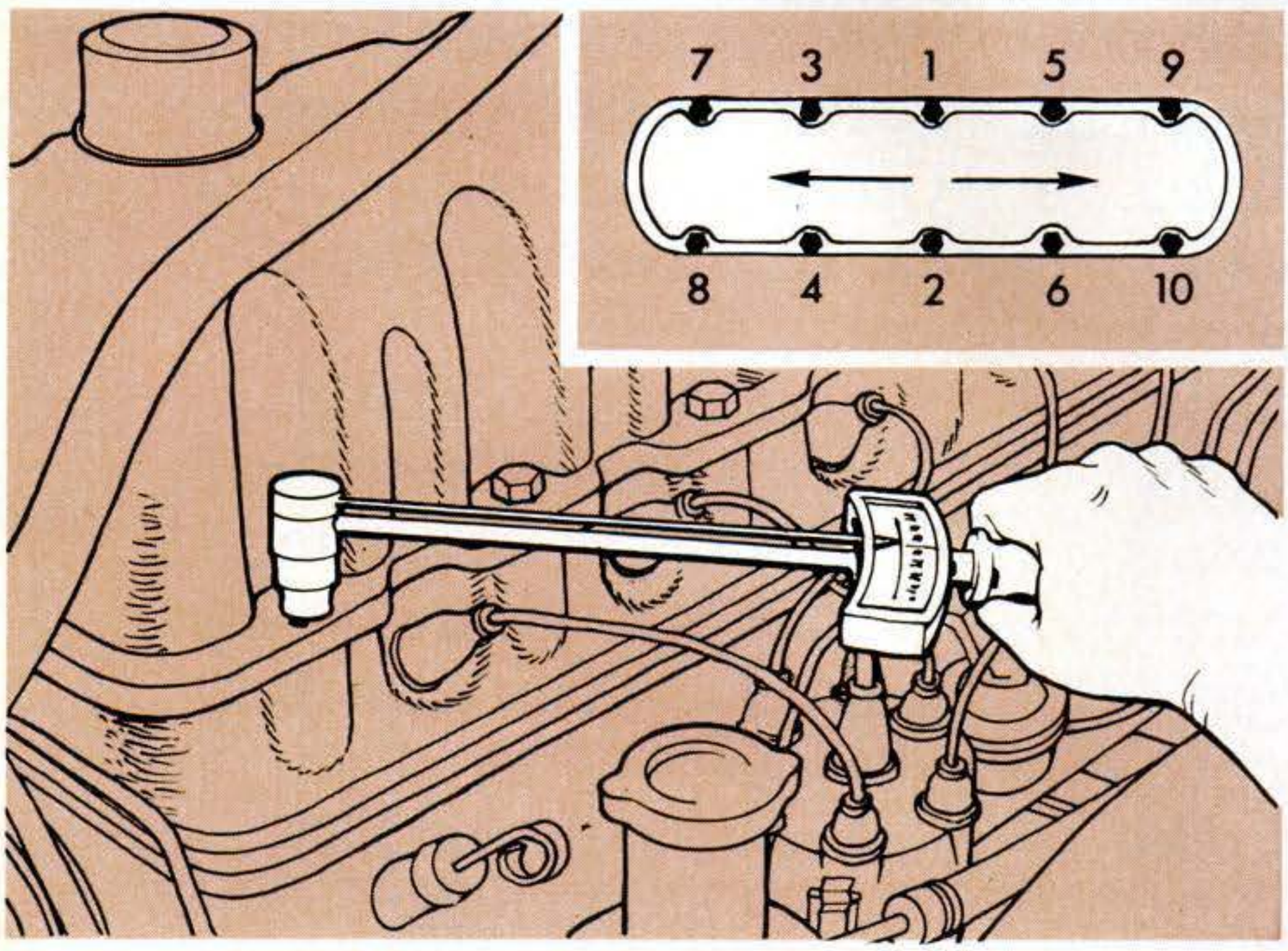
TAKING CARE OF YOUR CAR

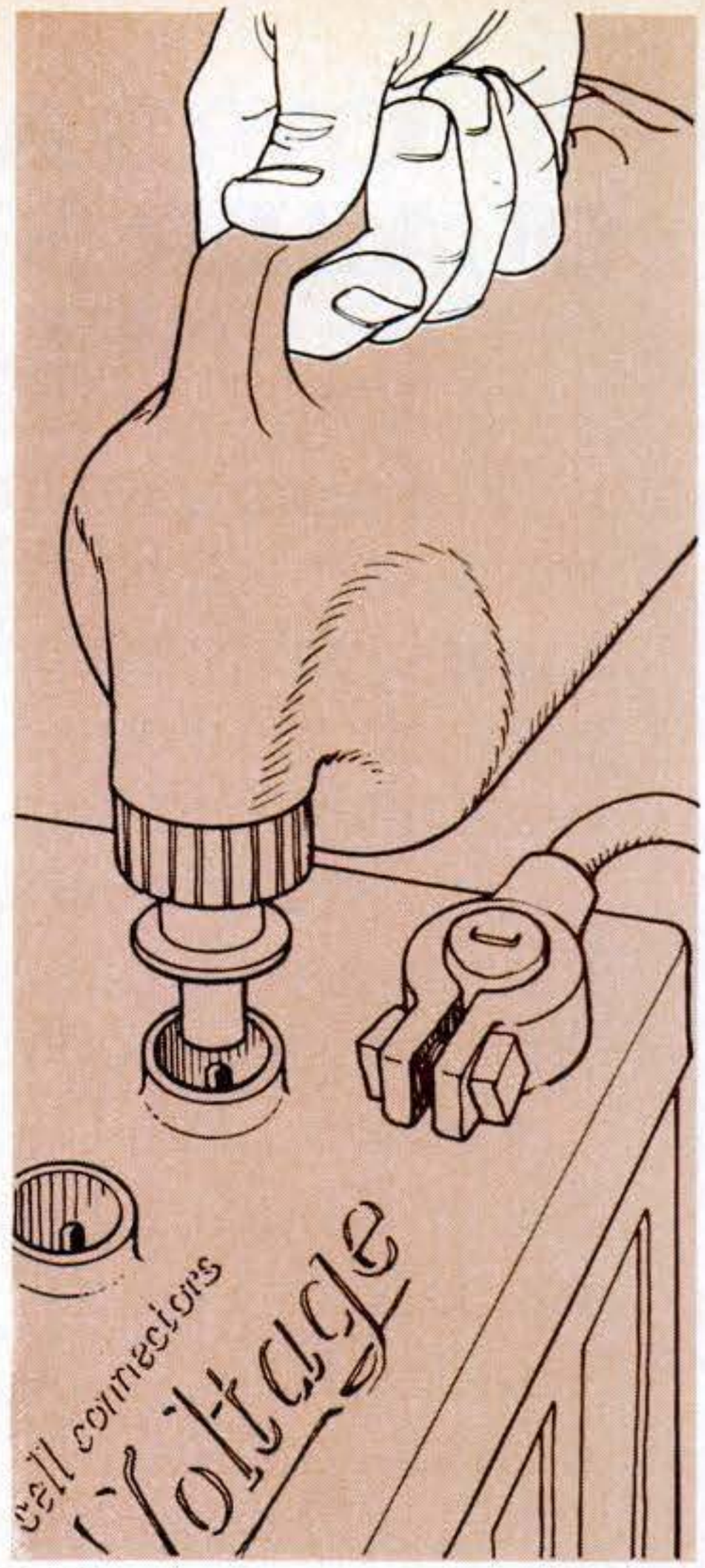
By RAY HILL

Got a useful car tip? Send it (with Social Security No.) to Car Care, Popular Science, 380 Madison Ave., New York, N.Y. 10017. We'll pay you $25 if we use it. If two or more readers send in the same usable tip, the one with the earliest postmark will be chosen. Sorry, but tips can't be returned.



Installing a new valve-cover gasket properly

Even new valve-cover gaskets can leak oil if they're not tightened properly. The best way, especially if the gasket is of the cork variety, is to turn all the fasteners finger-tight. Next, check the entire lip of the valve cover to make sure the gasket is still in place. Then, beginning from the middle and working out to each end of the cover, tighten these fasteners, using the same amount of force on each. If possible, use an inch-pound torque wrench, torquing the fasteners to your car's service-manual specs. If tightening by hand, still use this sequence.

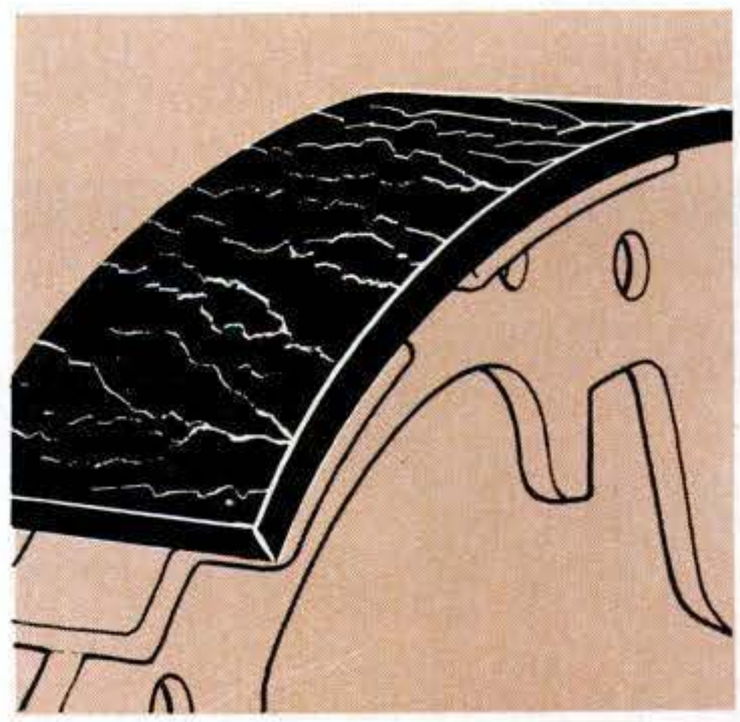


Adding battery water

f the temperature is below freezing, don't add water to your battery unless you're going to drive the car immediately. Otherwise the water may freeze, damaging the battery. When you do fill, the fluid level should reach the split-ring at the bottom of each fill hole.

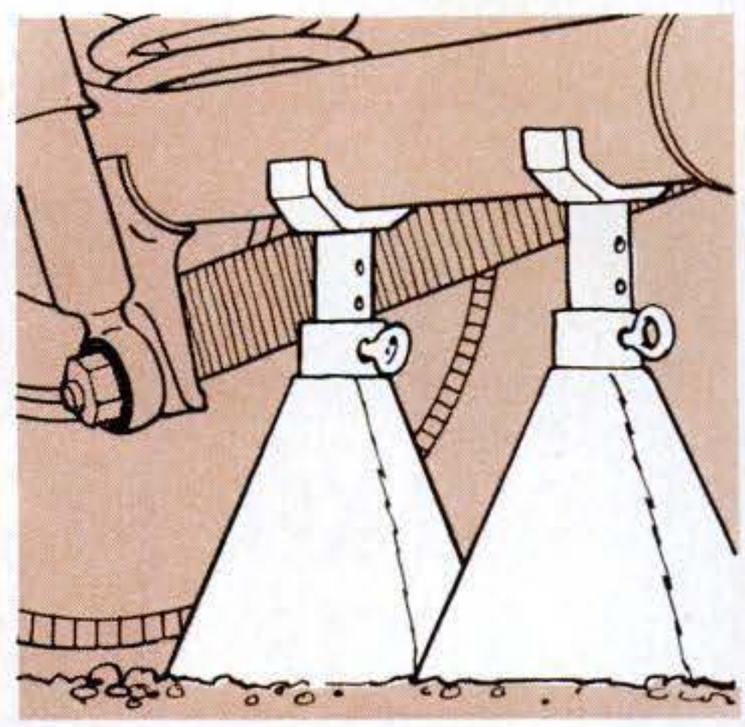
Protect those eyes

When using a hacksaw under a car—as, for example, when sawing a rusted clamp off your exhaust system—always put on a pair of safety goggles. This keeps the falling debris from coming to rest on your eyeballs. Safety goggles cost only a buck or so at many places that sell automotive supplies and tools—much cheaper than a visit to an ophthalmologist to remove the junk from your eyes. Many safety goggles fit over eyeglasses.



Cracks in brake lining

When inspecting drum-brake shoes, don't be concerned about surface cracks that may appear across the face of the brake lining, as long as they don't extend to any great depth. Studies have shown that there is no likelihood of lining loss due to superficial surface cracks. Nor has any connection between these cracks and brake noise been found. The cracks are due to manufacturing methods—not brake wear.



Use two jack stands

When using cheap jack stands to support a car, it's a good idea to use two instead of one, even if the weight your car places on the stand doesn't exceed the weight rating printed on the stand. But it reduces the weight each stand must support, and assures you that the car will be supported adequately. Never use any jack stand under your car if its rating is less than the weight of the vehicle it will support.

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$4147.00

Manufacturer's suggested retail price for base Dodge D100 pickup. Not including taxes, destination charges, or optional equipment. White sidewall tires and wheel covers $87.00 extra.

A reasonable price is one thing America wants in its blue jeans *and* its pickup trucks. Dodge gives you that . . . with the lowest priced pickup built in America* (and the lowest priced four-wheel-drive pickup,* too).

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Style and variety start with the clean lines of our base model Dodge D100 shown here and go all the way through the tricked up exteriors and elegant interiors of trucks like Ramcharger Four by Four, Warlock, and Macho Power Wagon. Just to name a few of the many Dodge models.

Visit your Dodge Dealer to talk about buying or leasing a Dodge pickup. He'll be glad to tell you about America's lowest priced pickups . . . and why, over the past ten years, Dodge has been the fastest growing truck company in America.

*Comparing manufacturers' suggested retail prices for base models.

†Source: R. L. Polk & Company. Trucks registered as of 7/1/76.

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Test read the ultimate riding mower.

Even at Toro, we've never engineered a precision mowing instrument quite like this.

For . . .

The Cut.

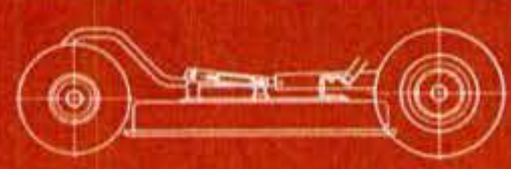
Each blade of grass has four chances to be sliced. For a cleaner cut.

FOUR CHANCES TO CUT PER PASS.

Cutting blade tips lift and fling clippings to the optional grass catcher.

Cutting speed won't slow, because blade drive's independent of the five forward speeds you match to mowing conditions.

The cutting deck floats. Front to back. Side to side. Anticipates



UNIQUE, FULL-FLOATING DECK.

your lawn's ups and downs. So there's less chance of scalping.

The cut is smooth, even. At any height from 1.6 to 4 inches.

The Comfort.

Floor's flat. No hump to bang an ankle.

Seat's deep cushioned.

Controls are close at hand.

The engine is counterbalanced to cut down vibration. And it's hooded to help hold down noise.

The clutch is like a car's. For smooth starts.

Steering? High helix through inclined spindles. For precise handling, straight tracking.

Pivoted front axle moves up, down. Absorbs bumps, so you don't.

To unload, stay in your seat, pull one lever and drop 5½ bushels of clippings. Or choose the catcher that puts 5½ bushels into two disposable plastic bags for you.

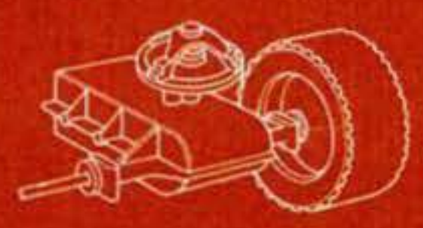
The Life.

We engineered durability into this mower. And low maintenance.

From the lifetime-lubricated transmission to the unique Toro two-clutch system.

One clutch for the transmission. One for the blade. Both extend belt life. What's more, t

What's significant too, with two clutches, there are no troublesome idler pulleys to adjust.

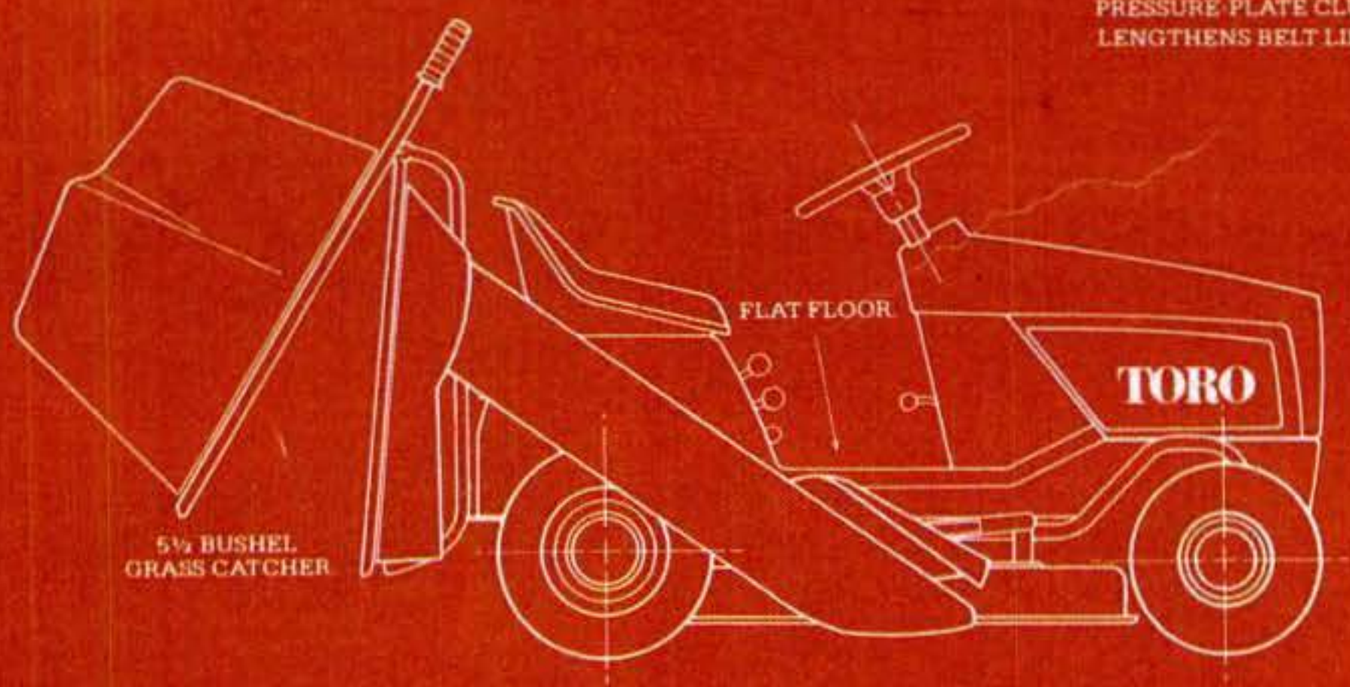


PRESSURE-PLATE CLUTCH LENGTHENS BELT LIFE.

A one-year limited warranty backs this mower just like our two medium-capacity rear-engine riders.

Your test ride's next. On any of five front-engine models. Examine these precision mowing

And by all means, do compare them to any other riding mower. See if we haven't engineered the ultimate.



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Haven't you done without a Toro long enough?™

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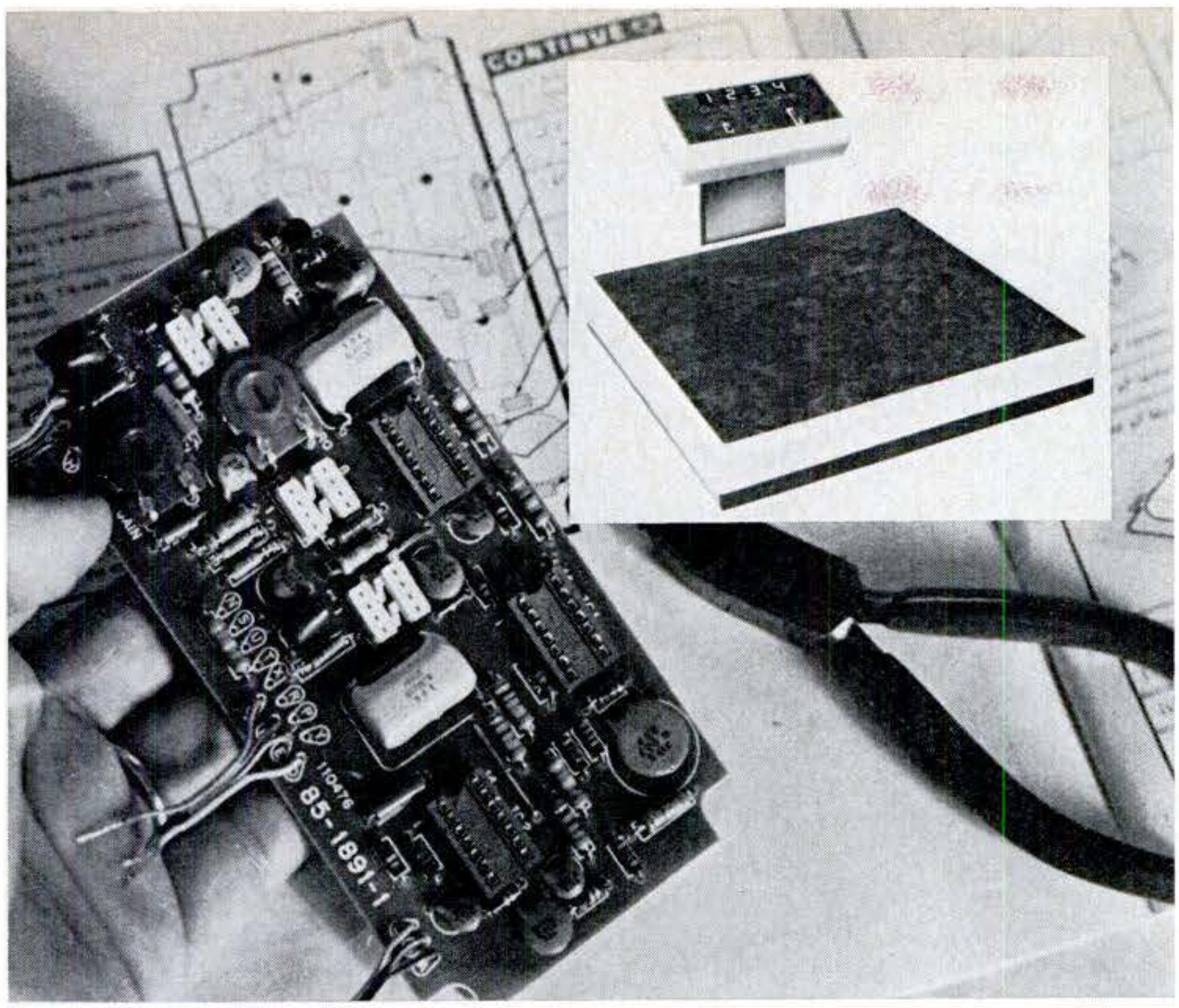

Digital bathroom scale
–build it from a kit

If you can face the bare, digital truth about your weight, flashed before your eyes in glowing, red numerals, you might like to build Heath's new "Digi-Scale" kit.

This electronic unit has a respectable plus-or-minus-one-percent accuracy and a plus-or-minus-half-percent repeatability. The display unit can be mounted on the scale, set on a nearby counter, or attached to a wall at eye level.

I recently assembled the kit in a leisurely 10 hours. The inner workings are not complicated, nor is the kit difficult to build. The key is a transducer consisting of a metal beam with four metal-foil strain gauges bonded to it. Step on the scale and you deflect this beam, changing the resistance of the strain gauges. This leads to a change in voltage.

Nearly all the electronic parts mount on two circuit boards. The first receives the changing voltage signal and converts it from analog to digital. The main ingredients of the second circuit board are four IC decade counters and the related digital display.

I encountered one glitch: One display showed a "9" when it should have shown a "4." Using the troubleshooting guide in the manual, I quickly found and corrected the problem, a solder bridge.

Calibration is simple. Each scale cover (the part you stand on) is weighed before it leaves the factory, and the weight to one tenth of a pound is written on the cover. Before completing the assembly, you calibrate the scale by dangling the cover from the transducer beam.

The scale can be built to read in one-tenth or two-tenths increments and in pounds or kilograms. (Two-tenth increments are better for weighing people, because the slightest shifting of weight causes the readout to change when the smaller increments are used.)

Six C batteries provide the power, and turn-on weight is adjustable. (Mine turns on at about 25 pounds. I didn't want the cat going to sleep on it and burning out the batteries.) The scale can be turned on manually for zeroing and weighing light objects. A potentiometer for zeroing the digital readout is located just below the red LED's. There's a low-battery indicator on the display. Current drain is about 250 mA, and Heath estimates that batteries should last about a year. Battery operation, of course, ensures that you won't be tangling with 120 volts AC when you're fresh from the shower. Price is $99.95 (kit) or $139.95 (assembled). From Heath Co., Benton Harbor, Mich. 49022.
—Greg Stone

Test a Toro today.

See the full line at your nearby Toro dealer. He's listed in the Yellow Pages under "Lawn Mowers."

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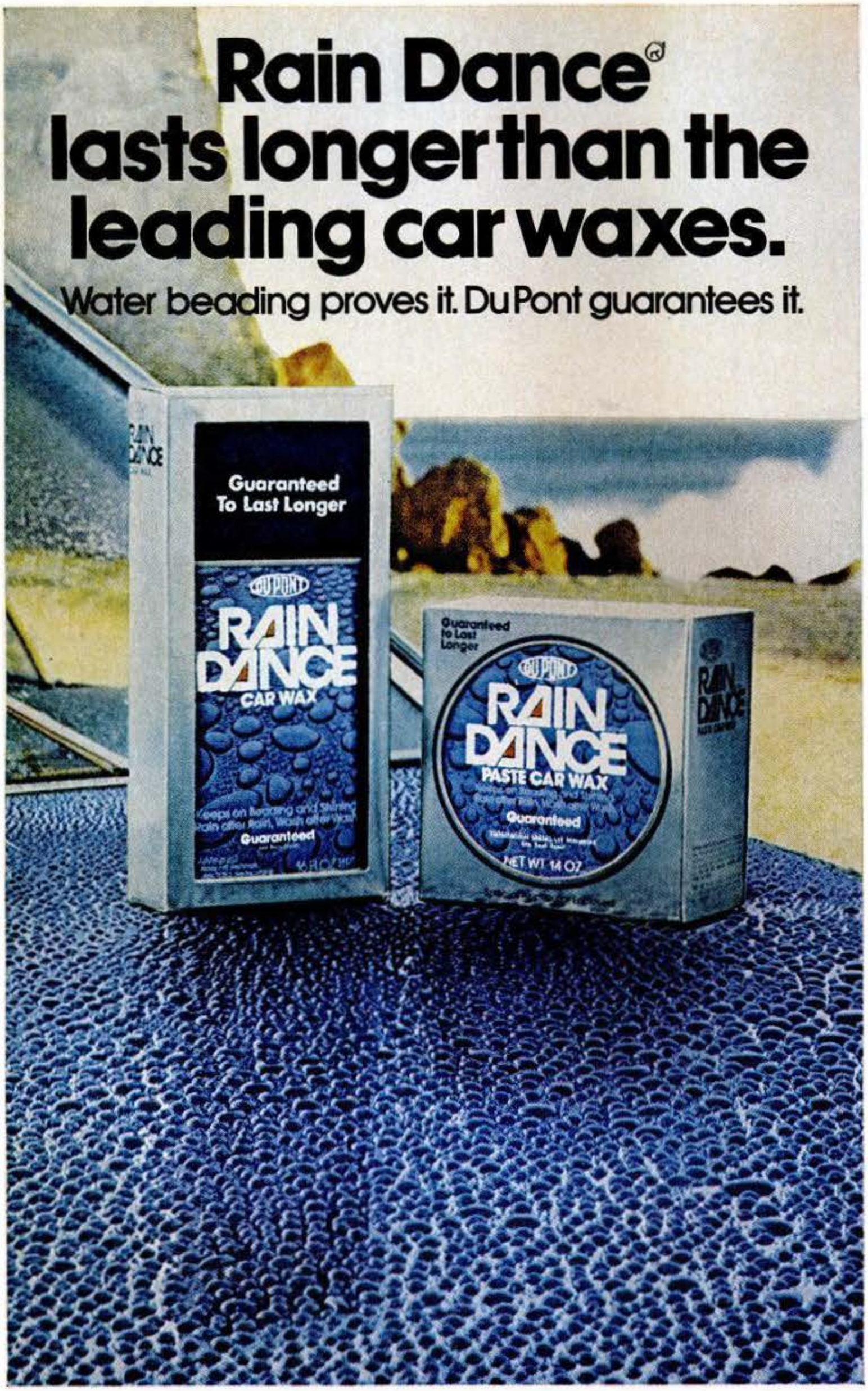
Rain Dance® lasts longer than the leading car waxes.

Water beading proves it. Du Pont guarantees it.



We tested 'Rain Dance' against all the leading car waxes...paste and liquid...and 'Rain Dance' keeps on shining longer, keeps on beading water longer, rain after rain, wash after wash. That's why we can guarantee it will last longer on your car. Premium-performance 'Rain Dance' is easy to use. It gives your car a fantastically brilliant shine because 'Rain Dance' cleans deep down as it waxes. And that shine lasts longer. Du Pont guarantees it.

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GUARANTEE: "RAIN DANCE" is guaranteed to keep on beading and shining longer than leading liquid or paste car waxes. If not completely satisfied, return unused portion to B-4233, Du Pont Company, Wilmington, DE 19898 for full refund of actual purchase price and postage.

Run-flat tire

[Continued from page 85]

ery set of flat-proofs. The sensor triggers a dash-mounted warning light to inform you a tire's gone flat. "The tires handle so well deflated that we were afraid people wouldn't realize they're out of air and would keep on driving them," says Robert Mercer, president of Goodyear's tire division.

The electromagnetic sensor consists of a pressure sensor/sender mounted on the rim like a balance weight and a pickup mounted on the car body or brake backing plate. When the sender passes the pickup it relays a signal if pressure is lost: The pickup then turns on the dash light.

You can get a flat-proof that's flat repaired at any service station that repairs conventional tires. "They're no different to repair than a normal radial," says Mercer. "But if you drive one too far and damage it, you'll have to buy a new one."

Goodyear will introduce the flat-proof as a replacement tire while Detroit makes up its mind whether it wants to install it on new cars. It will be available in F78-and narrower widths for 13-, 14-, and 15-inch wheels for any car that accepts radial tires. The installed price of a set of four, which includes the installation of deflation sensors on your rims, will be about $385, Mercer estimated. In turn you will surrender your spare tire and wheel to the Goodyear dealer. "The tires are ready to go right now," says Mercer, "but we've still got to train people to install the sensors, which will take some time." The flat-proof should be on the market by midyear.

Does this tire make sense?

Yes and no. It does reduce car weight and open up more trunk space. And it's a boon for people who must get where they're going in emergency situations, like doctors, police, and ambulances. It will also be useful for people who can't change tires. The flat-proof tire allows you to move quickly so traffic won't build up behind as you look for a spot to pull off. And people won't have to change tires in dangerous places.

But not having a spare tire and being forced to get a repair within 40 miles may prove inconvenient. Many people would rather change a tire and get the flat fixed at their convenience than search for an open service station. PS

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Introducing Ferrothane.™ Nobody's ever seen plastic rust.

Now you can seal outdoor metal things–like this wrought-iron table–in plastic with the wrist-and-brushwork of an ordinary paint job.

It's a cinch with Ferrothane Plastic Finish–the new outdoor metal coating from Flecto, the makers of Varathane® Liquid Plastic. You don't even need a primer.

Just brush Ferrothane over whatever prepared metal surface you'd like to shield from the elements: wrought iron furniture, gates, grillwork, garden tools, a storage tank, toys. Thanks to Ferrothane's ingredient Rustaid you'll get chemically formulated protection against rust and corrosion.

You'll also get a terrific-looking finish in a choice of 12 Ferrothane colors. Plus a coating that levels itself, spreads evenly, and dries in 4 to 6 hours. And gives outdoor metal things tough, long-lasting protection against rust, corrosion, mars, nicks and chipping.

How long will a coat of Ferrothane last? Well, when was the last time you saw plastic rust?

The Flecto Company, Inc.
P.O. Box 12955, Oakland, Ca 94604

To stop rust use Ferrothane.™

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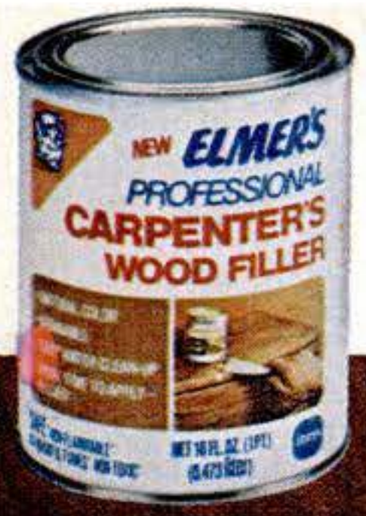
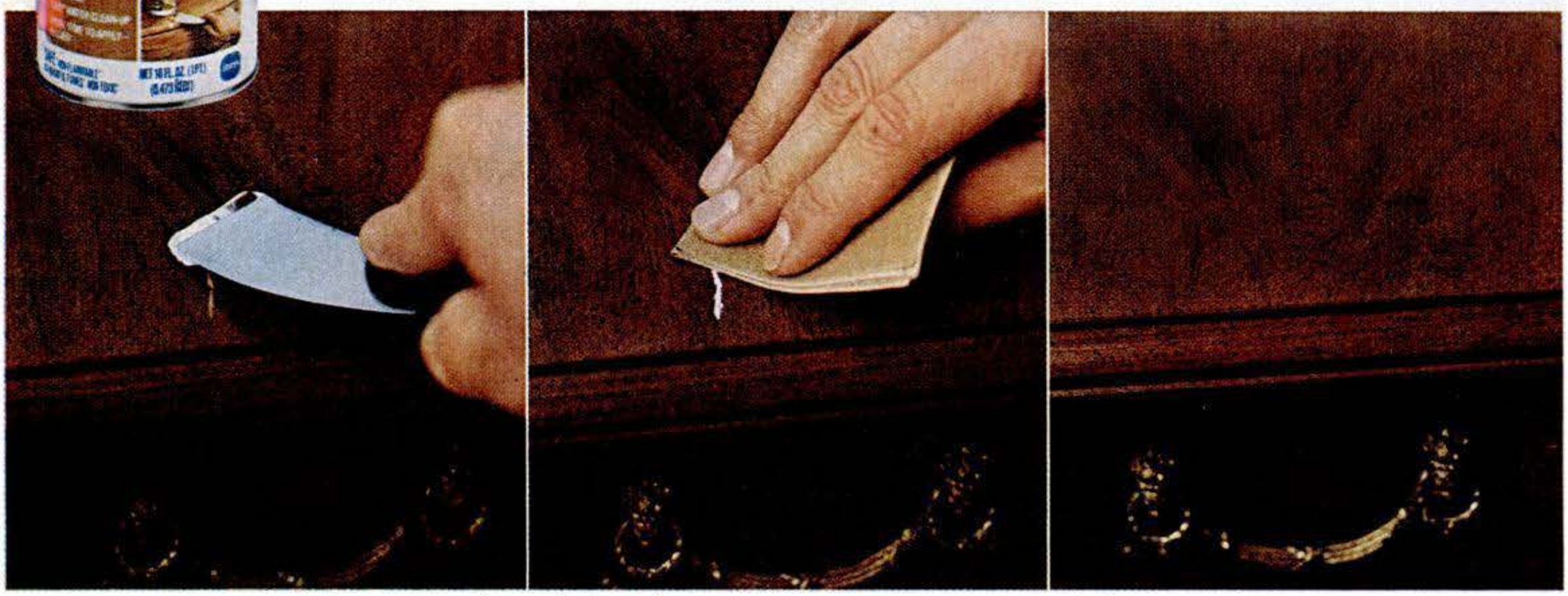


With Elmer's Carpenter's Wood Filler you don't need a pro's hands to give it the pro's touch.



Unlike the leading wood filler, Elmer's® Carpenter's Wood Filler contains no solvents. So it's safe and non-toxic* ...perfect for repairing finished furniture as well as raw wood. What's more, Elmer's Carpenter's Wood Filler is easier to "work" and won't pull out.

*As defined by Federal Hazardous Substance Act.

Its latex formula dries slowly (but not too slowly) and resists shrinking. Elmer's also washes off tools with water, but when dry it's water resistant. And it sands easier than solvent-type wood fillers. Elmer's unique formula stains better, disappears better...

In fact you can paint, shellac, varnish, saw, nail, screw, drill, plane, turn, route or carve it better than solvent fillers. Almost anything you can do with wood, you can do with Elmer's Carpenter's Wood Filler.

Elmer's. When results count.

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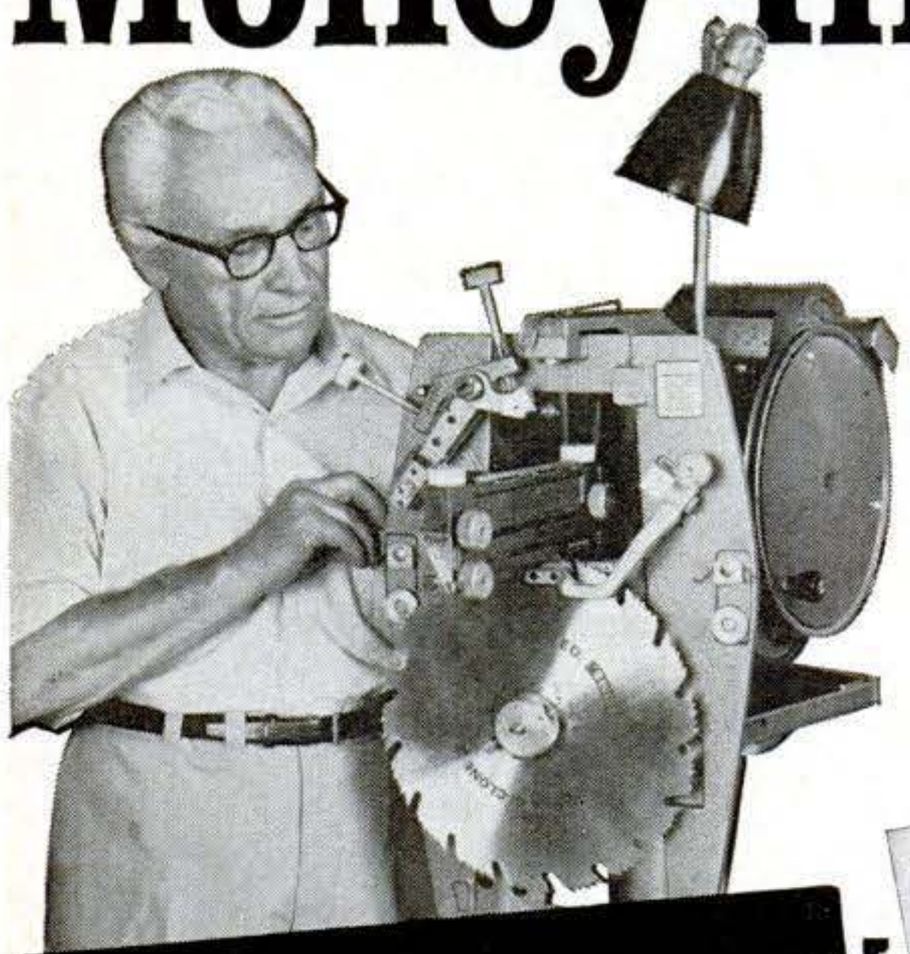

Here's a proven practical way to earn extra dollars in spare time—to develop a money-making repair business of your own. Investment is small. There's no overhead, no stock of goods to carry. No experience needed, no canvassing. You do it with the famous Foley Saw Filer that automatically sharpens all kinds of saws—and the Modern Lawn Mower Sharpener that precision sharpens all types of mowers.

EARN $5 to $8 An Hour Sparetime

Hundreds of people like yourself are making cash like this—$50 to $90 a week—right now in spare time. *"My spare time saw filing business has made me $952 these first few months" —says R. T. Chapman.* Many have built a complete sharpening service with such year-around profits. You can, too, simply by following the sure, easy Foley plan.

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[Continued from page 151]

Fuel-saving stoplights

With the great problems of energy and fuel consumption, I wonder why more is not written on the need for traffic-light synchronization. This seems to be a lost art.

Thirty-five years ago I studied on the north side of Chicago and lived on the far south side. On a Saturday afternoon I could drive 15 miles through the heart of the city, without the benefit of any freeways, before stopping once. I simply abided by the 28-mph speed limit—all lights were synchronized.

Today I live, without a doubt, in the most backward city, in the most backward county, in the most backward state: West Palm Beach, Palm Beach County, Florida. We have a six-mile-long main street, Okeechobee Boulevard. On a normal day, avoiding the rush hours, you stand still for eight-and-a-half minutes, waiting for the red lights along those six miles. The lights are synchronized in reverse. When this one goes green, the next one goes red. And this is typical of all of our main roads and streets.

We have something even more amazing: On our new Interstate 95 we do not have cloverleafs; we exit and enter on the wrong sides. We spend hundreds of thousands of dollars for overpasses and then install two stop lights on top of them or under them. And you should see them during rush hours when one lane of traffic is trying to cross another to get on or off the interstate. Both of these lanes interfere with the normal flow of traffic on the street under the interstate. Why should we have thousands of cars needlessly standing still, all burning fuel?

Elmer Anderson, West Palm Beach, Fla.

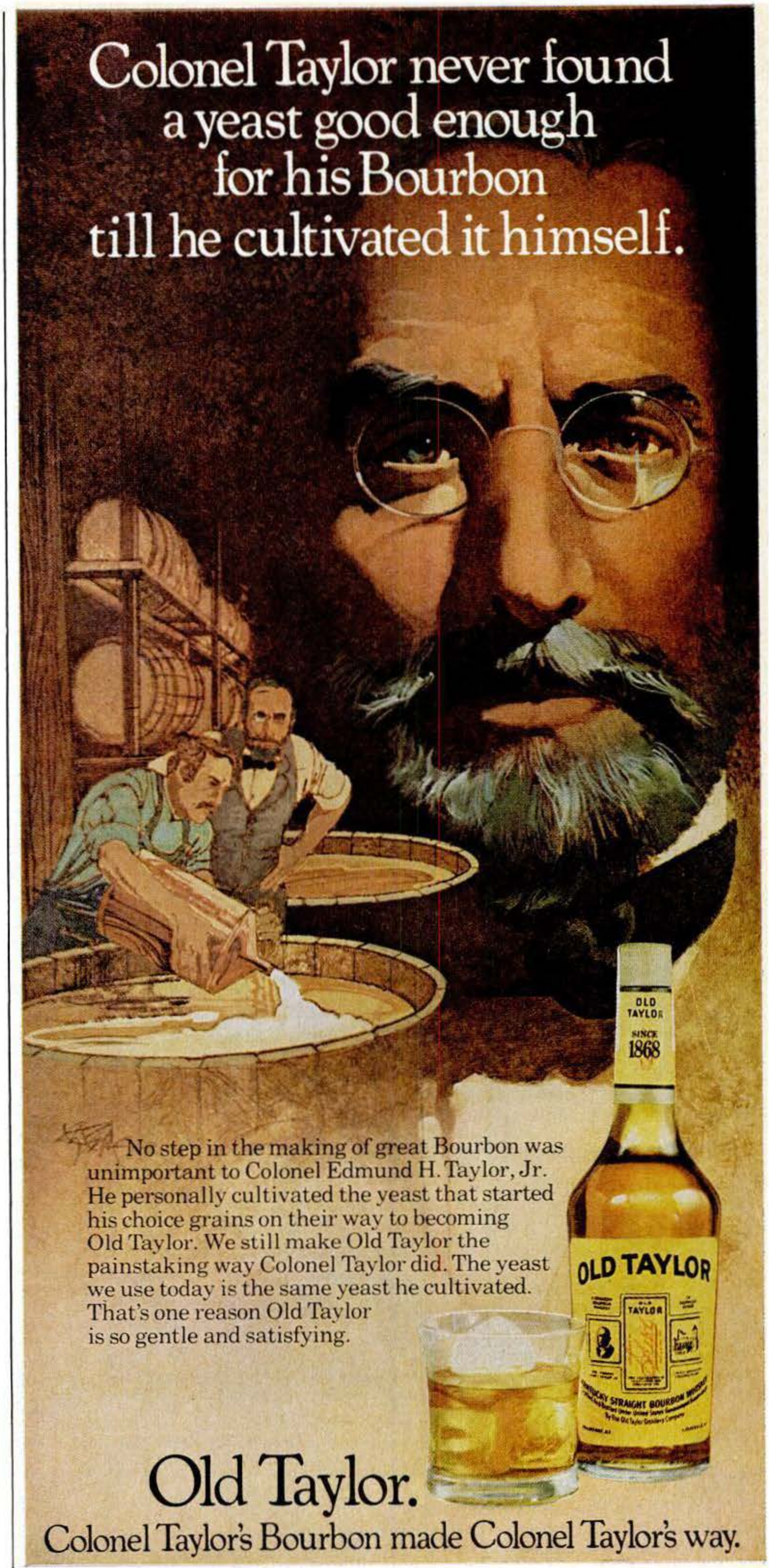
100-percent solar

Re your many articles with regard to solar heating, it is simply not true that a solar-heating system cannot be designed to carry 100 percent of the average heat load competitively against other systems. An air-to-rock system in Seattle, Wash., with a 50-percent air collector (not uncommon), requires 250 square feet of collector (at an average cost of $12 per square foot) and 350 tons of underground rock storage so that two-thirds of annual heating needs are gathered in summer and the balance in winter. I am sure that if it can be done in Seattle, it can be done elsewhere.

Right now people are spending their $10,000 bills on automobiles as if they are going out of style (which they probably are) instead of investing in solar and increasing the value of their homes. Only a few forward-looking people are making the change; plus, of course, a few sheep who have seen the smart ones jump beyond the hazard.

More power to you. Keep telling people about solar. They are just beginning to wake up to the facts that you have been giving them for years.

Al Abramson, President,
Sunpower Industries, Kent, Wash.



Kentucky Straight Bourbon Whiskey 80 and 86 Proof. The Old Taylor Distillery Co., Frankfort & Louisville, Kentucky

Semiconductors

[Continued from page 64]

for a specialized purpose, producing high-contrast screens to make literally letter-perfect plates for printing magazines.

Yet the real action is in the area that Ovshinsky named his company after—energy conversion. And here, chalcogenide glasses seem to be in a neck-and-neck race with amorphous silicon.

Energy-conversion devices

One breakthrough came in 1975 when Walter Spear and Peter Le Comber of the University of Dundee in Scotland announced they had developed a technique for modifying amorphous silicon so that it could be semiconducting. In essence, Spear and Le Comber added huge amounts of hydrogen to the silicon—anywhere from 10 to 30 percent of hydrogen. Apparently, the hydrogen atoms bond to the free electrons in the amorphous silicon, so that it turns into a semiconductor.

After the Scottish announcement, it developed that David Carlson and Christopher Wronski of RCA laboratories in Princeton, N.J., had been working on exactly the same effort, which had been kept quiet for commercial reasons. RCA later made the news public, describing the technique it uses and some results [Science Newsfront, PS, March].

RCA has reported achieving a six-percent-efficient conversion of sunlight in extremely small cells only a few millimeters across. "We're now doing a lot of work on scaling up to large areas," says Carlson. The major technical problem is that electrons can travel only a short distance, perhaps 300 angstroms, before they are trapped by defects. (An angstrom is one ten-billionth of a meter.)

"We would like to extend that to one micron" (one millionth of a meter), said Carlson. "If so, we can get to 15-percent-efficient conversion." That is a revolutionary statement. The big reason that solar cells aren't being made by the acre is cost: Crystals simply are too expensive to make. Carlson is talking about cheap stuff that would be used on a cheaper surface, like metal or glass. Experts say that this kind of material would be competitive with today's electricity sources at an efficiency of 10 percent. Carlson thinks the goal can be reached.

So does Ovshinsky, who is traveling his own road. Typically, he is making no small claims. At the House of Commons press conference, he said that he could produce a whole new family of amorphous materials whose electrical conductivity and heat conductivity could be tailored separately. Such materials could not only convert sunlight directly to electricity but could also convert waste heat to electricity. Ovshinsky conjures up pictures of electricity being generated from automobile exhaust pipes and factory chimneys using his devices. When I saw him at his home office, a few months after the European meeting, he was quite enthusiastic.

"We think that we can get up to 10 percent efficiency," he said. "This is really going to be a ubiquitous material in 25 years. There's little reason we'll want to make anything out of crystals."

That's not how Nobel laureate Philip Anderson, who works at Bell Laboratories, sees it. "Semiconductor chips are so far along that there is no way that amorphous materials are going to replace them in the near future," Anderson said. "When you can produce a chip for a programmable computer at under $10, the cost advantage of amorphous materials isn't much to talk about." Even in the field of solar cells, Anderson believes that "the most exciting developments today are in the area of amorphous silicon."

Anderson doesn't necessarily quarrel with Ovshinsky's science, but he does think that Ovshinsky has a tendency to oversell. "If you look in detail at what he is talking about, it doesn't look like today's technology yet."

Yet, Stan Ovshinsky thinks he can remake the world of electronics, and he's not afraid to say so. A lot of brilliant scientists think he's right. So do an increasing number of financiers and corporate executives, whose support is starting to pull ECD toward profitability.

"The point is," says Adler at MIT, "that while Ovshinsky has been running his company, he has also managed to do the scientific investigations which discovered switching, come up with a range of potential applications for amorphous materials, and also make contributions to the pure science of the materials. It's amazing." PS

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Stewart and Stevenson

The largest diesel stern-drives currently available come from Stewart and Stevenson. Its 1978 line includes five models, all of which are two-cycle engines. Two are three-cylinder units, 115 and 150 hp, a bit unusual for the stern-drive diesel market. Two four-cylinder models at 155 and 200 hp, and a six-cylinder 220-hp unit, round out the line.

The basic engines in S&S stern-drives are Detroit diesels, matched to heavy-duty Marine Drive Systems outdrives with oversized gears. This outdrive uses a circular transom collar that absorbs the thrust from a lower yoke. The lower pin of this yoke provides steering control.

The extension shaft within the outdrive unit is unusual. It's an internally splined hollow shaft that serves to keep thrust from the upper and lower gears independent of each other. Thus, there is a good likelihood that damage on one set of gears will not have direct or necessarily immediate consequences on the other.

Volvo

Last year Volvo offered five diesel stern-drives, this year only one. It has dropped the high-horsepower models, as well as two lower-hp units, and is retaining only the 130-hp AQD 40. This diesel couples with the Volvo 280 outdrive unit, and the entire engine/outdrive package, complete with standard fresh-water cooling, weighs 1025 lbs. There's also a new reverse gear, which Volvo calls the MS 3. The output shaft has a down angle of eight degrees, facilitating installation and giving a lower installed height.

Stern-drive or outboard?

Is a stern-drive best for your type of boating? The cost difference between two identical boats, one powered by stern-drive and the other by an equivalent-horsepower outboard, is very small. Outboards have risen more rapidly in price in the past five years than stern-drives. Also, when you select a stern-drive-powered boat the engines(s) and outdrives(s) are already mounted in the boat by the time it reaches the dealer.

For outboard hulls the dealer must mount the engine(s). Current labor rates run $18-$22 per hour, which further increases the cost of the outboards by $100 to $150 (or more) each, depending upon the complexity of the job. Thus, a typical popular 22-foot I/O with a single factory-installed 140- to 160-hp engine, complete with power trim, may carry a list of $12,000. The same hull designed for outboard use lists at $8000, and a 140-150 hp outboard, complete with power trim, carries a price tag of just under $4000. By the time both are in the water, they cost almost exactly the same. In some rare instances, the outboard rig may even cost a few dollars more.

Fuel-economy tests I've run show that an I/O cruises—horsepower for horsepower—on approximately 20 percent less gas than the outboard. And when it comes to slow trolling speeds, the stern-drive really shines. It will idle smoother and burn almost a third less gas than the same-size outboard.

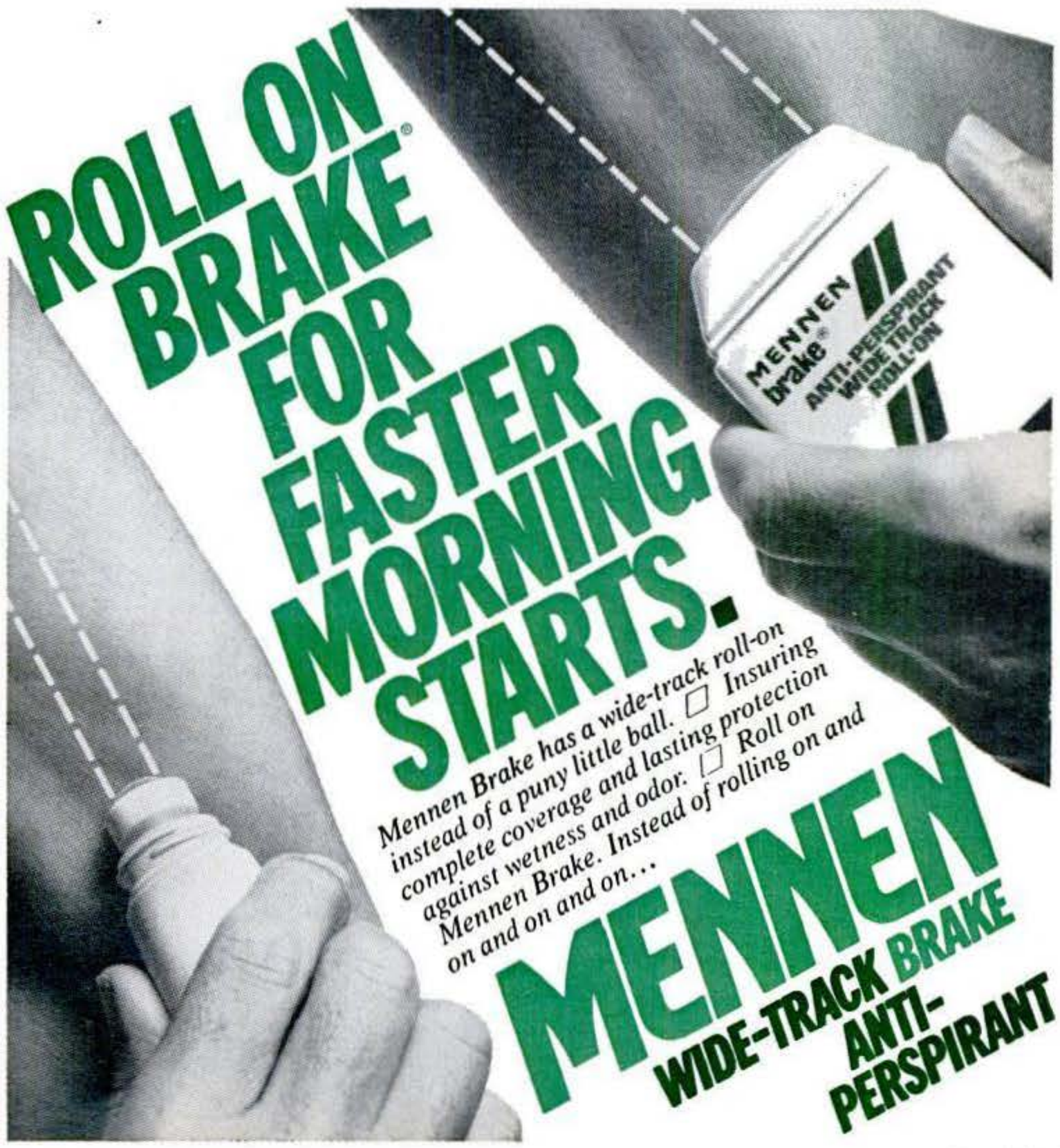
There are still boating situations where an outboard or inboard is perhaps a better choice than an I/O. Boats over 32 ft. in length are definitely better, in most cases, when powered by straight inboard power (ocean raceboats excepted). And under 18 feet, especially where shallow-water operation is concerned, the outboard is still the preferred power.

Also, the stern-drive skipper usually has a smaller range of power options and manufacturers to choose from. Usually, the buyer decides upon the the boat first, and then makes the choice of which stern-drive package to order with it from a selection, in most cases, of only two or three available horsepower and/or manufacturer options. It definitely pays to shop around. If you happen to like one manufacturer's boat because of its design, but don't like the power options available from that builder, look for a similar design from another company that uses other stern-drives. This will considerably increase your range of selectivity.

Remember, however, that installing a stern-drive unit in a boat is an extremely precise operation—far more so than hanging an outboard on the transom—and each builder tends to stick with those products that he feels are most easily installed and most satisfactory in his particular boats. PS

WHO MAKES 'EM:

Chrysler Marine, Box 1, Marysville MI 48040; **Mercury Marine,** 1939 Pioneer Rd., Fond du Lac WI 54935; **OMC Stern Drive,** 3145 Central Ave., Waukegan IL 60085; **Renault Marine Couach,** 505 SE 27 St., Ft. Lauderdale FL 33136; **Stewart & Stevenson Services Inc.,** Box 1637, Houston TX 77001; **Volvo Penta of America,** Box 1546, Chesapeake VA 23320.



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JUST DIAL

SELECTOGRAPH® for fast answers to your fix-up problems!

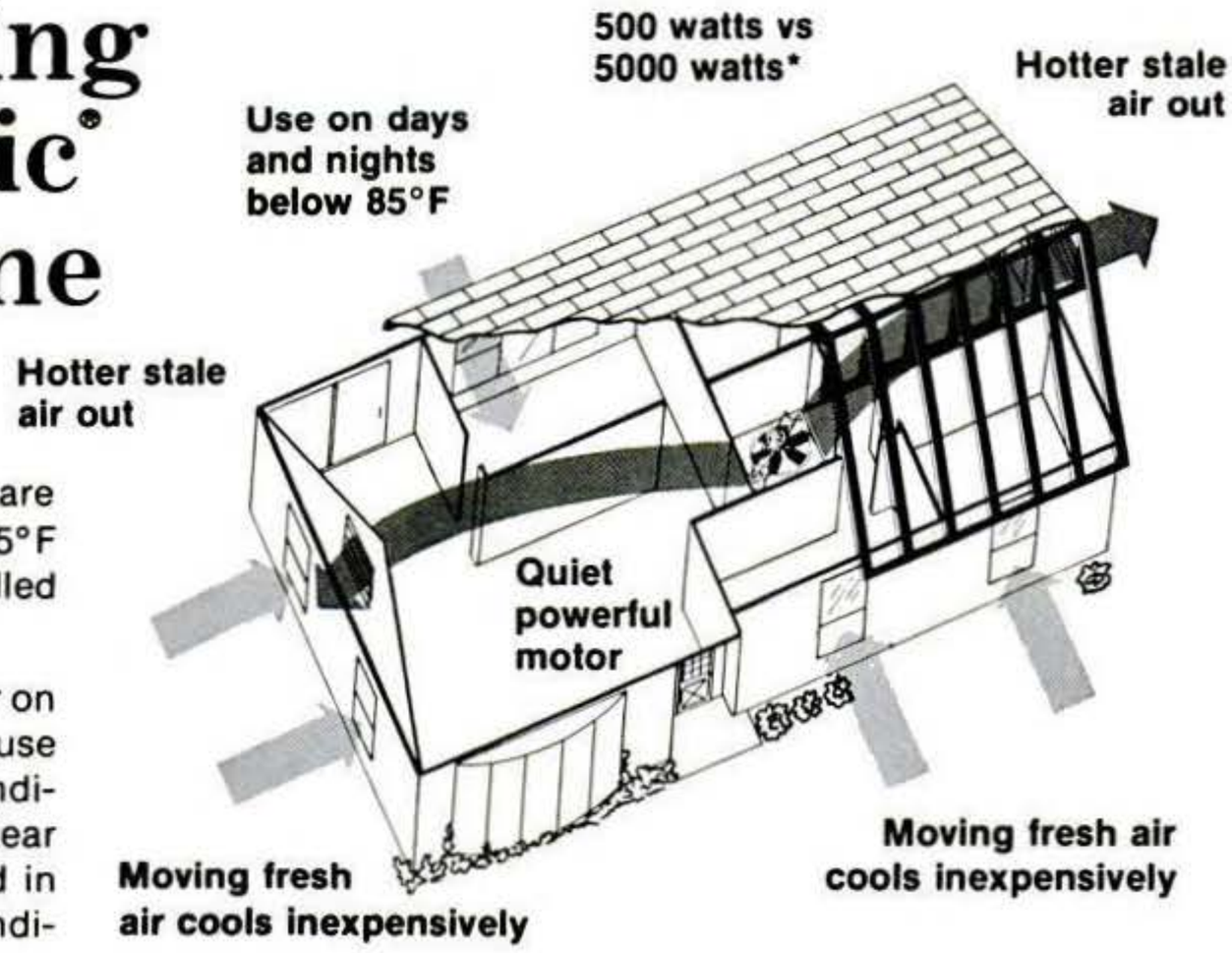
Now, SELECTOGRAPH makes your home fix-up load a little lighter! It tells you the "which" and "how" behind the correct DURABOND® product to use to do the job right. And no matter what you're fixing to do, DURABOND covers your needs for surface preparation products, adhesives, caulks and sealants—including five new nonflammable products. You'll find the handy SELECTOGRAPH on a chain at most hardware and home centers. Give it a whirl for easy fixing!

Look for the red, white and blue nonflammable label on these new products.

DURABOND

Products by United States Gypsum Paint Division, Chicago, Ill. 60606

Save twice on cooling costs with Cool Attic® Total Comfort Home Ventilator.



Sure there are days you want air conditioning. But there are lots of days and nights when the temperature is below 85°F and all you really need is a comfortable breeze being pulled through the house.

If you had the Cool Attic Total Home Comfort Ventilator on those days, you could save twice. You could save first because the ventilator uses about 1/10 as much energy as an air conditioner.* You'd save a second time by reducing wear and tear on your air conditioner because it runs fewer days. And in some instances, it eliminates the need of expensive air conditioning completely.

How does the Total Comfort Home Ventilator work? Very simple. When mounted in a central hallway ceiling, the ventilator pulls air into the house through open windows, and exhausts it through the attic. This moving air cools naturally, inexpensively.

The Total Comfort Home Ventilator is also a do-it-yourself dream. It's easy to install with a few household tools. Our easy-to-follow instructions give you the step-by-step details.

Install a Total Comfort Home Ventilator and enjoy its low-cost cooling benefits for years to come. Visit your do-it-yourself center that features the complete Cool Attic line.

*Based on power consumption of selected air cooled, condensing units, 36000 BTU, various manufacturers. Source—1977 Directory, Air-Conditioning and Refrigeration Institute

COOL ATTIC CORPORATION
Dept. A48 P.O. Box 11558
Fort Worth TX 76109
1-800-433-1626
0-817-921-3081 Ext. 28 (in Texas call collect)

Quality Products for Do-It-Yourself Energy Savings

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How to Achieve Total Financial Freedom

A MUTUAL CONCERN. We've never met and probably never will, but I think we share a common interest. That interest is in achieving complete and total financial freedom.

Recently my net worth reached the *magic million dollar mark,* and it only took me 48 months to achieve that.

That might not impress you, but if you had seen me just a few years ago, you might wonder how I did it. I lived in Denver then, in a cramped, tumbled down house at 2545 South High Street. My wife was expecting our second child and we were so broke we had to borrow $150.00 from a relative just to buy food and pay the rent.

By the way, I know I didn't make a million dollars because of my superior intellect — I barely got through Ames High School (Ames, Iowa) with a C average. I did a little better later on but I soon realized that a salaried job was not the way to become financially free. If you'll stop and think, you'll realize that millionaires do not work 10, 20, or 50 times harder or longer than you.

FINANCIAL FREEDOM. It seems that most people who are charging for financial advice have studied how to "do it" but have never actually "done it" themselves. You will find as you read my formulas, that since I have actually achieved total financial freedom myself, that you will receive from me more than just the motivation to achieve your own financial independence, but a workable step-by-step plan to actually do it.

STEP-BY-STEP. Contained in the work entitled ***How To Wake Up The Financial Genius Inside You*** are the various formulas which will show you exactly how you can do each of the following:

- buy income properties for as little as $100 down.
- begin without any cash.
- put $10,000 cash and more in your pocket each time you buy (without selling property.)
- compounds your assets at 100% yearly.
- legally avoid paying federal or state income taxes.
- buy bargains at one-half the market value.

MORE LEISURE. If you apply these formulas and methods you will find in a very short time, you will be able to do almost anything you care to do, and I think, at that time, you will find as I have, that spending several weeks on the beaches of Hawaii, or on the ski slopes of Colorado, or just sightseeing in Europe, or any other place in the world, you begin to understand what **real freedom** is all about.

Most people think that it would be impossible to do some of the things listed above. For example, to buy a property, and at the same time put $10,000 (or more) cash in your pocket without selling the property, or to buy a property with little or no cash down.

Believe me, it is possible and fairly simple. This is exactly how most wealthy people actually do make 10, 20, or 50 times more money than you do.

What are your Financial Possibilities in 1978? Mark O. Haroldsen became a millionaire in four years because he found a way to harness inflation to his benefit. Now it's your turn! *"I've found"* says Haroldsen, *"that most people just need a specific road map to follow . . . they can do what I've done."*

YOUR MONEY'S WORTH. While I was struggling on making my first million, I often thought how nice it would be to have the personal advice and counsel from someone like Howard Hughes or J. Paul Getty.

What would I have been willing to pay for this service? I can tell you one more thing for sure, it would have been a lot more than the $10.00 that I'm going to ask you to invest in your financial future.

". . . more than 150,000 people have discovered that my formulas will provide the road map that can lead to total financial freedom . . ."

FOR YOUR FUTURE. What will this $10.00 actually do for you? It will give you a complete step-by-step plan that you can follow to become totally and completely financially independent.

Please try to understand my dilemma. I'm not a New York advertising agency with all their professional skill and manpower to write a powerful and persuasive ad to convince you that I can make you financially independent. I am just somebody who has actually 'done it', and can really show you how to 'do it'.

TEST IT YOURSELF. It's really quite frustrating to have something so valuable as I know I have, but lack the skill to convince people to try it for themselves. I hope by my simple direct approach I can convince you to try my formulas.

INDECISION — THE COSTLY DECISION. It seems the majority of the people in our rich country lose, not because they lack intelligence, or even willpower, but because of procrastination, or lack of action — please don't be like the masses. Make a decision while you have this paper in your hands. Make a decision now to either act now and send for my material or immediately round file this paper. If your decision is to order, do it now, not later. Otherwise you may lose, just by default.

"FINANCIAL FREEDOM." To order, simply take any size paper, write the words "Financial Freedom," your name and address, and send it along with a check for $10.00 to Mark O. Haroldsen, Inc., Dept. G-266, Tudor Mansion Bldg., 4751 Holladay Blvd., Salt Lake City, Utah 84117.

If you send for my materials now, I will also send you documents that will show you precisely how you can borrow from $20,000 to $200,000 at 2% above the prime rate using just your signature as collateral.

IT'S GUARANTEED. If you are still somewhat skeptical, and believe me, when I started out I certainly was, because of the many people in the world trying to deceive others, I would encourage you to postdate your check by 30 days, and I promise and guarantee that it will not be deposited for at least those 30 days, and if for any reason you do not think that what I have sent you lives up, in every aspect to what I told you in this letter, send the material back, and I will quickly, without question, refund your money and send back your own uncashed check or money order.

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Inquire at your local bookstore for Mark Haroldsen's "How to Wake Up the Financial Genius Inside You."

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The Hot One.

The BernzOmatic Jet Torch, the most trusted name in torches.

It's one of the most versatile home repair tools you can buy.

The BernzOmatic Jet Torch can solder, seal, loosen bolts, heat tile, remove paint and window putty, remove ice, thaw frozen pipes—the list goes on and on. You can even use it for hobby and craft applications. And the BernzOmatic Jet Torch does it all easily and economically!

It's no wonder that for over 20 years, do-it-yourselfers have recognized the BernzOmatic Jet Torch as the first and best torch for a variety of home repairs.

Don't put off those home repairs any longer. See the BernzOmatic Jet Torch at your BernzOmatic dealer's soon.

BERNZOMATIC®

BERNZOMATIC CORPORATION, ROCHESTER, N.Y.

Hydraulic windmills

[Continued from page 10]

in an insulated heat-storage tank.

Hot water is drawn from the tank and circulated through ordinary radiators for space heating. A return line carries the water back to the tank for reheating.

The wind-heat economics

"We're not aiming to heat the greenhouse entirely by wind power," says Pontin. "But to heat an acre costs around $20,000 a year in oil. If we can reduce this by only a quarter we're in business."

The machine at Efford has a maximum installed power rating of 150 kW with a wind speed of 30 mph and the rotor spinning at a brisk 140 rpm. With a possible selling price of $35,000, that comes to around $200 per kilowatt of thermal energy at an 85-percent conversion efficiency. Such a rock-bottom figure is purely academic, however, since mean annual wind velocities are actually much lower than that.

The energy cost depends on a basic physical law: Power generated increases as the *cube* of wind velocity. With a 10-mph wind a kilowatt works out at $8500, dropping sharply at 20 mph to only $730. But Pontin doesn't talk in terms of static unit costs. His yardstick for energy production is kilowatt-hours based on average wind speed over a year for a given site. With these calculations, he argues, his windmill package could have a real price edge on other energy sources. PS

"We were out of #12 wire, so I brought you two rolls of #6 . . . . okay?"

The Hot One, II.

The brand-new BernzOmatic Jet Torch II, the most versatile propane torch you can buy.

It outperforms any other propane torch! The BernzOmatic Jet Torch II burns with heat so highly concentrated, it can actually braze-weld metal. It can handle literally hundreds of do-it-yourself jobs requiring strong, weld-like repairs. And because the BernzOmatic Jet Torch II concentrates the heat, it can do them much faster, too.

Look at the home repair jobs it can do—and the time and money it can save you in replacement costs. Repair garden tools, lawn mowers, toys, fences and metal furniture. Use it for metal sculpture, auto body work, metal bending, and many other jobs.

See the BernzOmatic Jet Torch II at your dealer's soon.

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[Continued from page 72]

of overload distortion must be distinguished from amplifier overload or clipping. Although phono cartridges are given nominal output ratings (based upon how many millivolts they will deliver when tracking a record groove at a given "wiggle velocity"), the cartridge may deliver many times that amount under conditions of musical reproduction, when a loud musical passage is encountered. Typically, a cartridge having a nominal output of 2.5 millivolts under test conditions may put out 20 to 30 times that level when it is called upon to track wide groove modulations (loud moments in the recording). Now, since some cartridges may have nominal output ratings as high as 5.0 millivolts, such cartridges may, on occasion, actually deliver 150 millivolts or more. The Fisher RS-1035 might be in trouble when used with such a cartridge, while receivers such as the Pioneer SX-650 and the Sansui G-3000 could handle input signals of up to 200 millivolts before the phono-preamp section would exhibit high orders of distortion. Once distortion has occurred in the early preamplifier-phono stages, no amount of volume-control manipulation (which affects only the power-amplifier section of the receiver) will correct the situation, and the distortion will be heard regardless of listening level.

Listening tests

Unless you have a great deal of listening experience, you won't be able to detect nearly as much difference in overall sound quality when judging one receiver against another as you will when comparing speaker systems. All 14 receivers we auditioned sounded very much the same when reproducing phonograph records at moderate listening levels, using a low-output cartridge. As we pushed for higher and higher sound levels, using a meduim-efficiency pair of loudspeakers, differences caused by power-output limitations became apparent. Units such as the Advent 300, Kenwood KR-2600, and Marantz 2216B reached audible clipping levels first—an expected result, in view of their lower (15 to 16 watts per channel) power ratings.

As you can see from the table, the published power ratings of the 14 receivers tested ranged from a low of 15 watts per channel to a high of 35 watts per channel. While this may seem like a very wide range of power-output capabilty, remember that a doubling of power results in an audible level change of only three decibels. While that level change is certainly audible to

Continued

A note about Dolby FM

If you own a stereo cassette tape deck you're probably already familiar with the Dolby noise-reduction system. In this two-part system treble sounds are pre-emphasized by increasing amounts as musical loudness level decreases during the recording. In that way, low-level treble notes are pushed up above the noise threshold of the tape. During playback, a corresponding amount of treble attenuation is progressively introduced for low-level music. This restores flat frequency response over the entire audio spectrum at *all* levels of music being reproduced and at the same time reduces tape-hiss level by as much as 10 dB.

The very same idea is being applied to FM and stereo FM broadcasting by an ever-increasing number of stations. During Dolby broadcasts, however, the pre-emphasis and de-emphasis standard is altered. In order to overcome noise in FM, standard broadcasts also pre-emphasize treble tones by a fixed amount. Your receiver has a corresponding de-emphasis circuit, known as a 75-microsecond de-emphasis characteristic, which restores flat frequency response. In standard FM, however, this de-emphasis or treble roll-off is fixed and doesn't vary with signal intensity as is the case with Dolby.

To take the fullest advantage of the Dolby noise-reduction system in FM, it was necessary to change the standard pre-emphasis values and de-emphasis values from 75 microseconds to 25 microseconds. This enables Dolby FM broadcasters to increase the dynamic range of their broadcast material and to avoid the necessity of compressing or limiting the musical peaks being broadcast. If, however, you try to listen to a Dolby FM broadcast using a standard FM receiver and a suitable Dolby decoder connected in the path of the recovered audio signal, you'll find that the music will lack treble or brilliance. Your receiver is attenuating highs by a greater amount than they have been boosted at the station. If, on the other hand, you try to listen to a Dolby broadcast on a standard set without hooking up a Dolby adaptor, low-level musical passages may seem overly shrill or brilliant while high-level passages may lack brilliance.

Unless your receiver is already set up for 25-microsecond operation, you'll need to convert the de-emphasis network in your receiver and interconnect a separate Dolby decoder.

The unique BernzOmatic Oxygen Cutting/Welding Torch, the first professional-style welding rig for do-it-yourselfers.

It's the ultimate torch! Like a professional rig, the new BernzOmatic Oxygen Cutting/Welding Torch can cut, weld, braze and solder, yet is much handier and easier to use. It's totally portable and fits easily into tight spots not easily accessible with a professional rig. It's even styled like a professional rig and uses real oxygen and either propane or Mapp gas (Reg. trademark Airco, Inc.) supplied in separate cylinders.

What's more, you can use it for all types of indoor and outdoor household repairs, from plumbing to jewelry-making, and for auto body work and van conversion.

See the amazing BernzOmatic Oxygen Cutting/Welding Torch at your dealer's soon.

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HANDY IDEAS FROM BIG RED T.M.

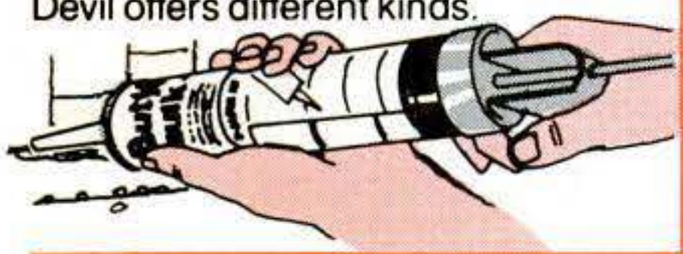
A handy man to have around the house.

More home fix-up tips from the pro.

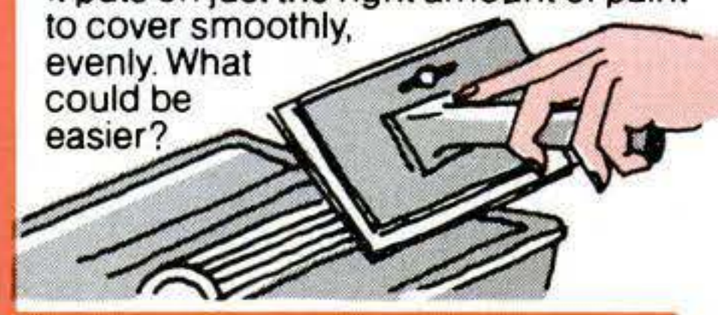
Fill the tub before you caulk. (Get in if you can, too.) Then, when the tub is empty, it'll rise slightly and squeeze the caulk. Even a good flexible caulk (like Red Devil's) will serve you longer when the filled weight is not stretching it between the tub and wall.

Save money when you save energy. This new 72-page Energy-Saving Book has dozens of do-it-yourself energy-saving tips that can save you hundreds of dollars. The cost is only $1.25 plus 50¢ postage and handling. Send check or money order to: Save Energy, Dept. F1 Box 310, Maplewood, N.J. 07040.

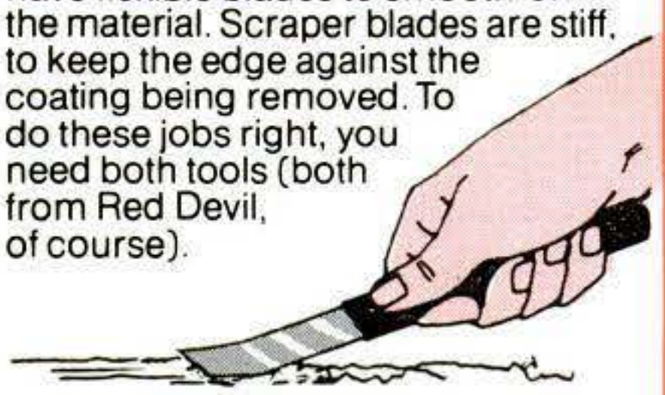
Caulk is caulk is caulk? Wrong! Latex or acrylic latex caulk provide excellent durability (especially when painted) and easy clean-up for most uses, but you'll need butyl caulk for the water resistance required at or below ground level. Different caulks for different jobs, that's why Red Devil offers different kinds.



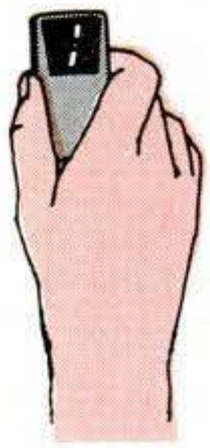
Go easy on the paint with your pad painter. If you let the pad soak up too much paint, you won't get the best possible results. That's why Red Devil has a patented metering tray designed especially for pad painters. It puts on just the right amount of paint to cover smoothly, evenly. What could be easier?



A putty knife is not a scraper. And vice versa. Putty knives (for spackling walls and puttying windows) have flexible blades to smooth-on the material. Scraper blades are stiff, to keep the edge against the coating being removed. To do these jobs right, you need both tools (both from Red Devil, of course).



Stud finders are un-holey. When hanging pictures on a freshly painted or papered wall, don't fill it with holes before you find the wood behind it. Use a Red Devil Stud Finder. It points out where nails are—and where there are nails, there are studs.



Red Devil has hundreds of things to make your home fix-up easier. Look for them wherever you shop for home-care products. And for best results, always follow directions on the package.

Red Devil ®

UNION, N.J. 07083

most listeners, it is far from a doubling of *apparent loudness,* since human hearing sensitivity follows a logarithmic rather than a linear curve. For a sound to seem twice as loud as another sound, it is necessary to increase sound power level (and therefore amplifier power feeding the loudspeaker) by a factor of 10-to-one, or 10 dB!

If the features or performance of lower-powered receivers appeal to you, but you can't get loud enough sound from them, your solution is to choose a more efficient pair of loudspeakers to work with them.

The most economical higher-powered (35 watts per channel) receiver in the group evaluated is the Technics (by Panasonic) Model SA-5270, which boasts rather good FM performance specifications and control features as well. All of the other 35-watt-per-channel receivers considered (Fisher RS-1035, JVC JR-S200-II, Pioneer SX-650, Realistic STA-85, Rotel RX-503, and Superscope R-1270) carry the identical suggested retail price of $300, so that choosing between them becomes a matter of evaluating performance features other than power: reception quality, ability to handle the phono cartridge of your choice, extra control features or switching flexibility, and, yes, even how the receiver will fit in with the rest of your system and with the decor of your listening room.

Consider, for example, the special feature found in the Realistic STA-85, the Superscope R-1270, and in the slightly lower-priced and lower-powered Sherwood S-7210A. Each of these receivers has extra sets of speaker output terminals which can be connected to a second pair of speakers positioned behind you to create a form of synthesized four-channel sound effect. Many listeners find that this arrangement contributes to a feeling of concert-hall ambience and increases enjoyment of music listening.

After I completed this survey of these low-cost receivers, I could not help but be impressed by the incredible amount of performance that is available to audio enthusiasts at relatively low cost. I believe that the receivers represented in this study (and they are by no means the only ones we could have selected in this price category) represent extremely good value for their price and will serve most listeners well. PS

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LET'S CLEAR THE AIR ABOUT SPRAY PAINTING.

When it comes to spray painting, most people are still in a fog. Literally. No matter how much easier it is to spray than brush, you end up painting more than you intended. You can't get away from it with air compressor paint sprayers.

Wagner Spray Tech came up with a solution to all that pollution. The Power Painter. An electric, airless spray painter that applies latex, oil base paints, stains, and varnishes. And because it's airless, there is little overspray!

Power Painters W280 and W350 will paint anything from fences, to decks, to a pontoon boat. An optional five foot suction tube allows you to paint from the paint can.

To find out more, mail in this coupon for a free Power Painting booklet.

WAGNER SPRAY TECH

WAGNER SPRAY TECH

Please send me a FREE copy of "Discover Power Painting," an illustrated guide to quick and easy painting.

Name:_____

Address:_____

City:_____ State:_____ Zip:_____

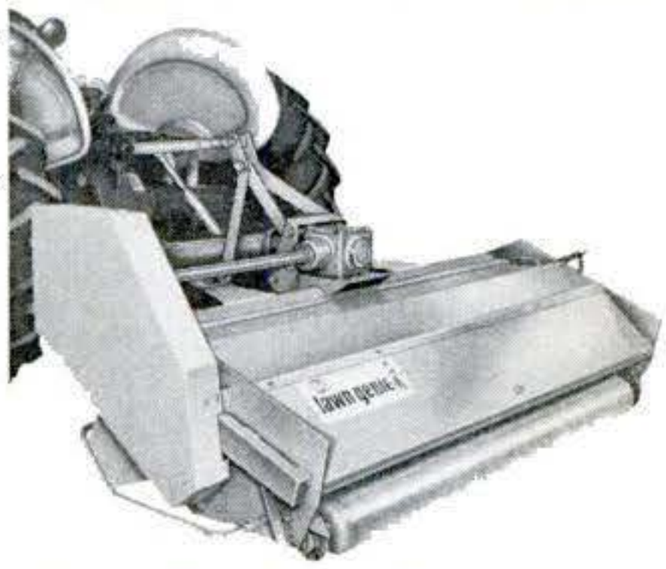
Mail to: Wagner Spray Tech Corporation
Dept. L, 1770 Fernbrook Lane
Minneapolis, Minnesota 55441 B1

SPRING SUMMER FALL

M-C MATHEWS COMPANY

PICK-UP MOWER

THE THREE SEASON MACHINE



Spring—Thatch your lawn. Clean out dead grass and pick up winter debris. Summer—Mow smoothly, evenly for beautiful patterned cuts. Fall—Leaf sweep, mulch, and load in one pass with easy access controls without leaving your tractor. M-C Pick-Up Mower is a flail type mower for home, estate, park, or school lawn care. Powered by its own 8 H.P. gasoline engine, the 36" model can be pulled by your garden tractor. Rugged 5 ft. and 6 ft. P.T.O. tractor powered models wade into tall grass with surprising ease. For big jobs you'll be interested in the new 3-gang 36" models. Get with the fast dependable year 'round machine that cleans, mows, and sweeps as no other can.

3 point hitch on 5 ft. and 6 ft. models permits contour hugging cuts on uneven ground. Gauge Roller prevents scalping. All models available with or without Hopper.

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See your M-C dealer or mail this coupon today. (Dealership inquiries invited)

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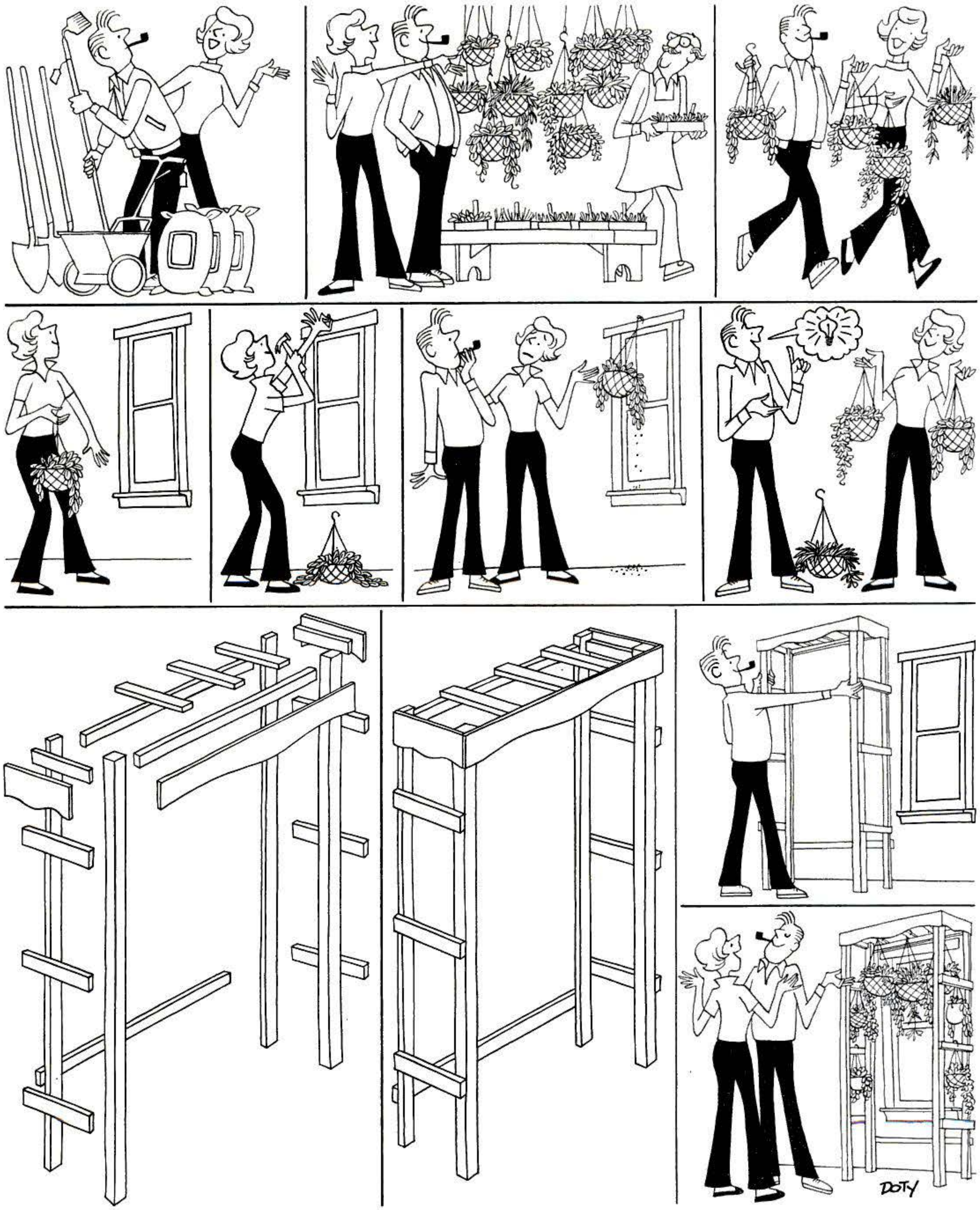
WORDLESS WORKSHOP

By ROY DOTY

$50 to Robert Dow of Trenton, N.J., for this idea. Send yours (with Social Security No.) to Wordless Workshop, Popular Science, 380 Madison Ave., N.Y., N.Y. 10017. Only purchased ideas can be acknowledged.



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- **No more "making do" with just anything you have on hand!**
- **No more "drugstore quality" terminals and connectors!**
- **No more high prices!**
- **No more less-than-professional repair jobs!**
- **No more frustrating searches for the right piece of electrical hardware!**
- **No more time-consuming soldering!**
- **No more Saturday-morning trips to the hardware or electrical supply store!**

BONUS BUY!

A Stanley, industrial-quality "Jobmaster" crimper at our wholesale cost!

Limit: One crimper per shop. Crimpers not sold separately.

All high-quality, 99% conductivity, plated copper terminals and connectors. Meet or exceed UL, CSA, and (where applicable) OEM standards. **Not** inexpensive "stamped-out-tin" hardware. No "seconds" or "rejects." All high-quality!

Truly over $100 worth of hardware alone! Check out prices yourself . . . you'll be amazed!

Unconditional 30-Day Guarantee: If you're dissatisfied in any way or for any reason, just return your Shop(s) within 30 days for an immediate, full refund. No questions asked!

Exactly what you receive: One 25-tray, polystyrene bin-cabinet (tray dividers form 45 bins). 1,011 terminals, connectors, and electrical accessories. 25 preprinted, color-coded I.D. labels. One FREE Specifications Chart.

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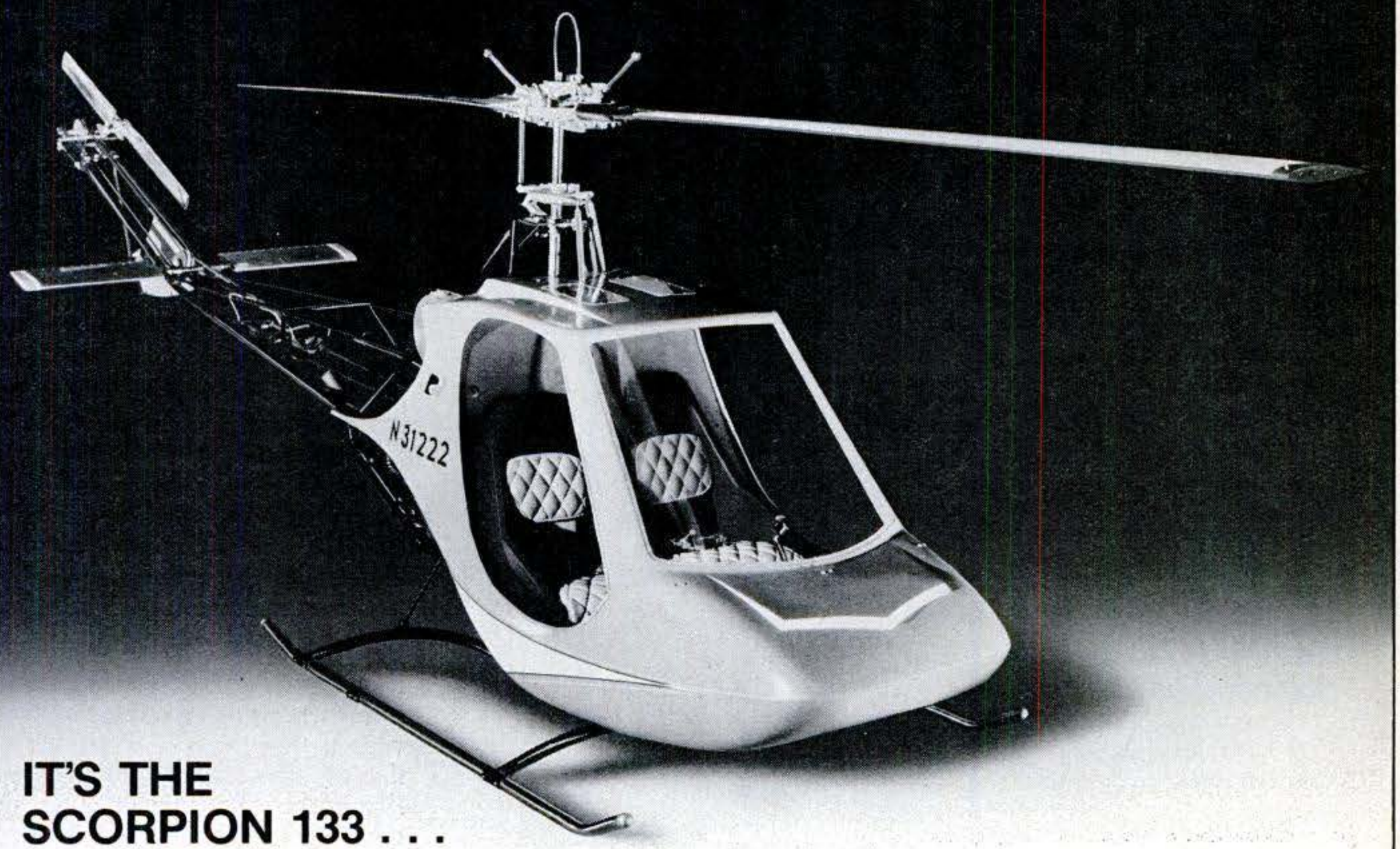

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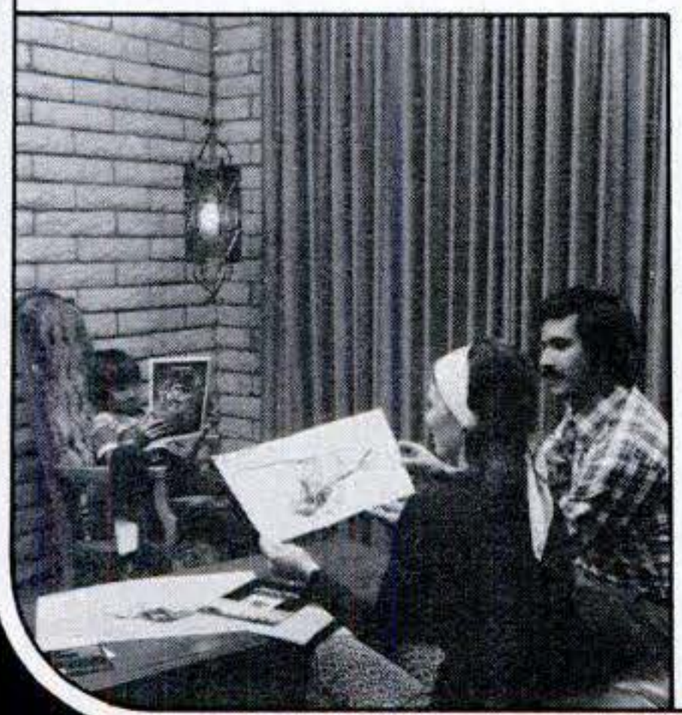

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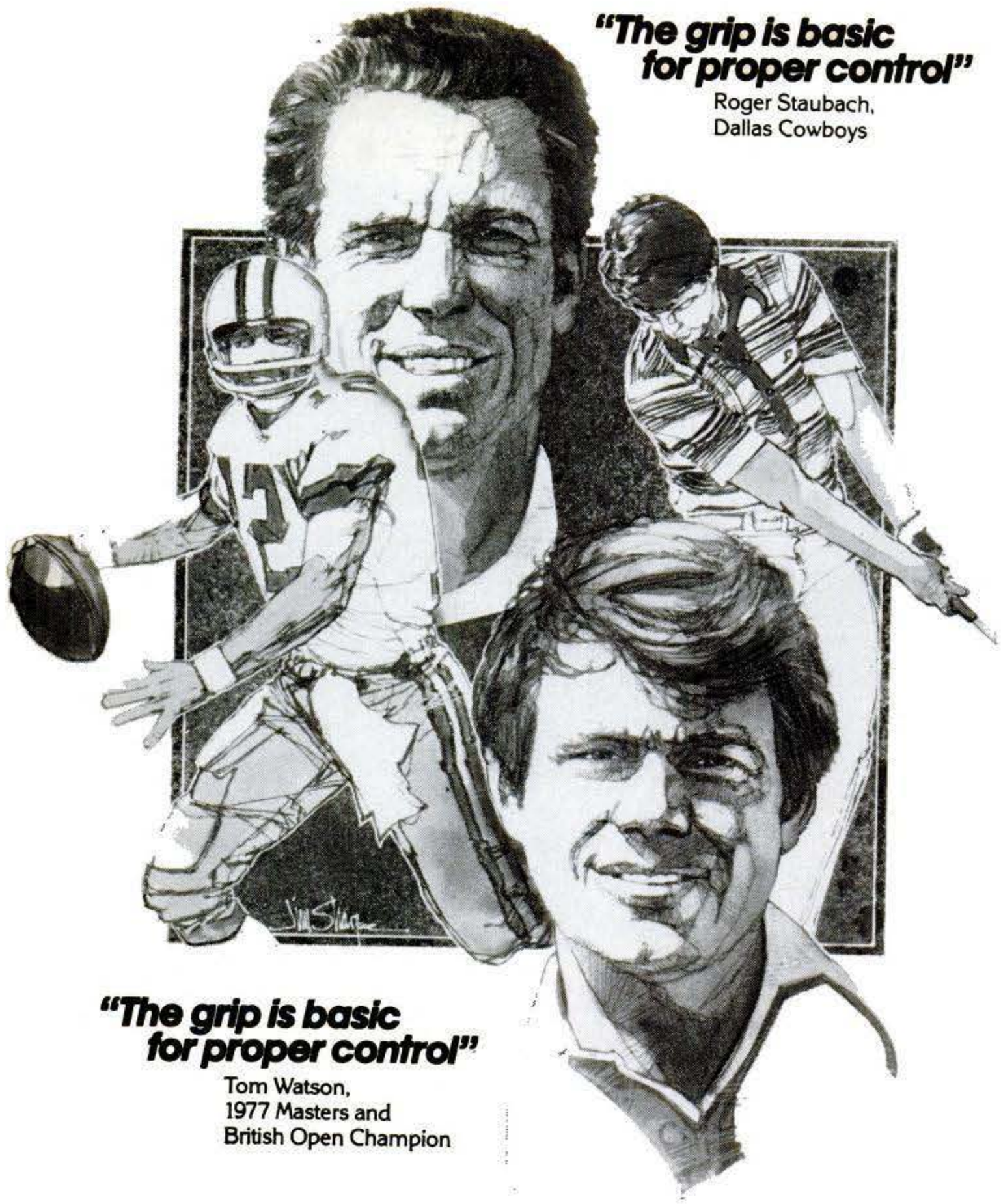

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Slow breeder reactor

[Continued from page 91]

ever, in order to fully test the new slow-breeding process, Shippingport will be operated continuously for three or four years. Then the entire core will be removed and shipped to the Idaho National Engineering Laboratory for analysis.

Shippingport shows its age. Walking toward the reactor building, with its rusty steel wall panels, I was impressed with the contrast between this bleak structure and the modern concrete dome of Duquesne Light's newest 1000-megawatt light-water power reactor under construction a few hundred feet away. Shippingport had been operated successfully for more than 17 years as a working nuclear power station prior to its shutdown in 1974 because of a steam-turbine failure. The facility was then overhauled to current nuclear-plant standards.

The reactor building itself is little more than a warehouse that holds the pressure vessel and core. The enormous coolant pumps and related machinery are underground. We entered a small observation room with large glass windows looking down on the submerged top of a huge tank containing the pressure vessel. The crystal-clear water reflected the soft glow of several floodlights. An adjacent pool shielded us from the old light-water core, still waiting to be removed.

In Shippingport's main control room, the instrumentation is neatly laid out in separate panels for the reactor, turbine, and generator controls. From his swivel chair, the operator on duty casually glanced from meter to meter. There were relatively few instruments on display. After all, Shippingport is only about six percent of the size of the newest light-water reactors.

The most important changes—those making slow-breeder operation possible—are hidden inside the new breeder core. Weighing about 90 tons, the eight-foot structure is built to an accuracy of one one-thousandth of an inch to insure that all available neutrons are put to work making energy or breeding more fuel.

About 1100 pounds of U-233 are mixed with approximately 40 tons of thorium and sealed inside tubes of zirconium alloy in the form of ceramic pellets. The pellets are made by pressing the two fuels together under great heat and pressure.

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More LWBR conversions?

The decision to convert the Shippingport light-water reactor to a LWBR core was particularly significant because the basic technology used by all pressurized light-water reactors was developed at the old Shippingport plant.

Westinghouse Electric Corporation, which operates the Bettis Atomic Laboratory for the government, is working on reactor-core designs that electric utilities could use to make U-233 in their own light-water power reactors. There may be some loss of generating capacity after conversion, and initial fuel costs will be higher since more U-235 is required to convert the thorium. However, once a sufficient amount of U-233 has been bred, the LWBR's won't need any more natural uranium. Long-term savings could be significant.

"While a thorium LWBR can't produce nearly as much new fuel as a fast breeder," says William H. Hamilton, Bettis' general manager, "we believe that Shippingport will make slightly over one percent more fissionable uranium than it uses." He explained that what little excess fuel is produced may not be recovered during normal fuel reprocessing and refabrication operations. "But there will always be enough fissionable material on hand to replenish the LWBR and keep it running," he said.

In the meantime, neutron measurements within the LWBR core indicate that it is performing as expected and is likely to meet its breeding objectives. According to Admiral Rickover, whose naval reactor group first proposed converting Shippingport to a light-water breeder in 1965, "The Shippingport light-water breeder has come within three-tenths of one percent of our calculations."

The light-water breeder reactor certainly isn't the answer to all of our energy problems. But it may help keep nuclear energy flowing for several centuries at only a modest increase in cost. The entire program to develop the LWBR concept, test it at Shippingport, and make the technology widely available will cost about $408 million—almost $100 million less than the capital cost of a single, large new nuclear power plant starting up two years ago. The thorium LWBR could be our best nuclear-energy bargain in a long time. PS

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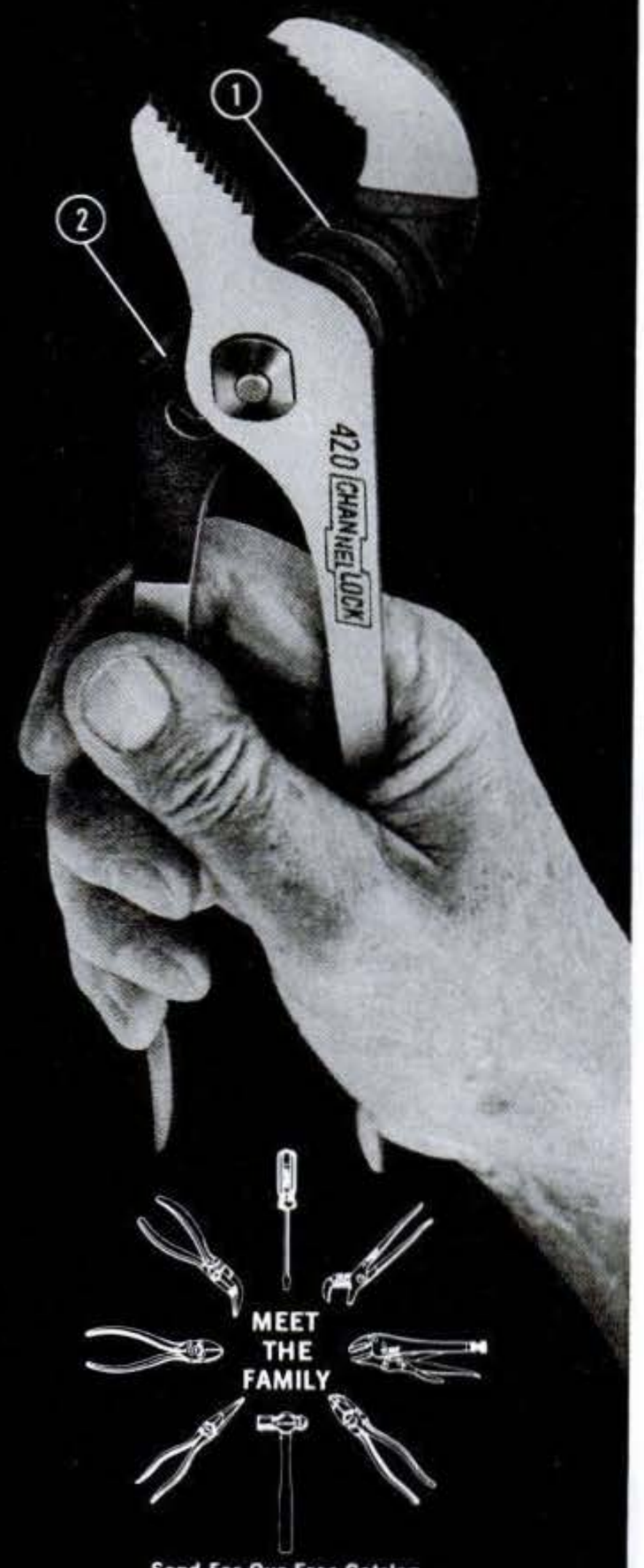

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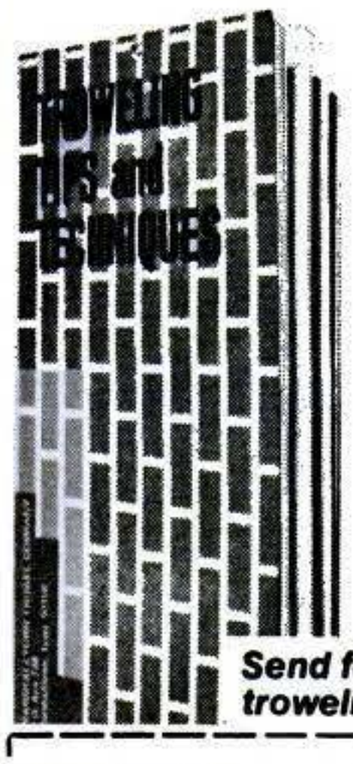

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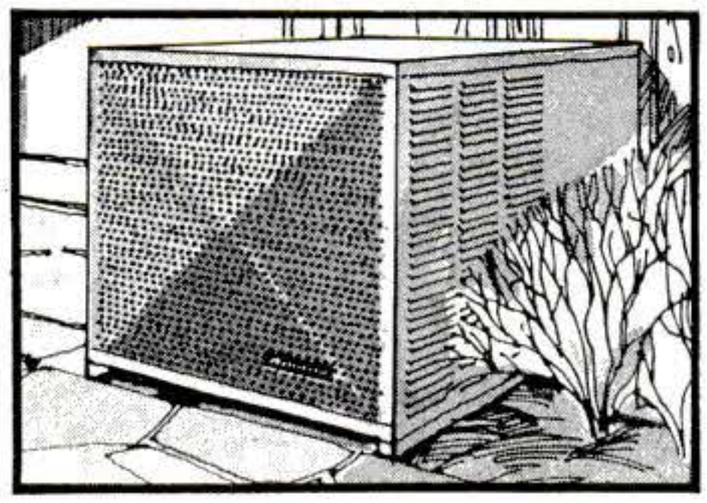

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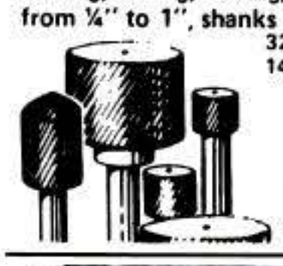

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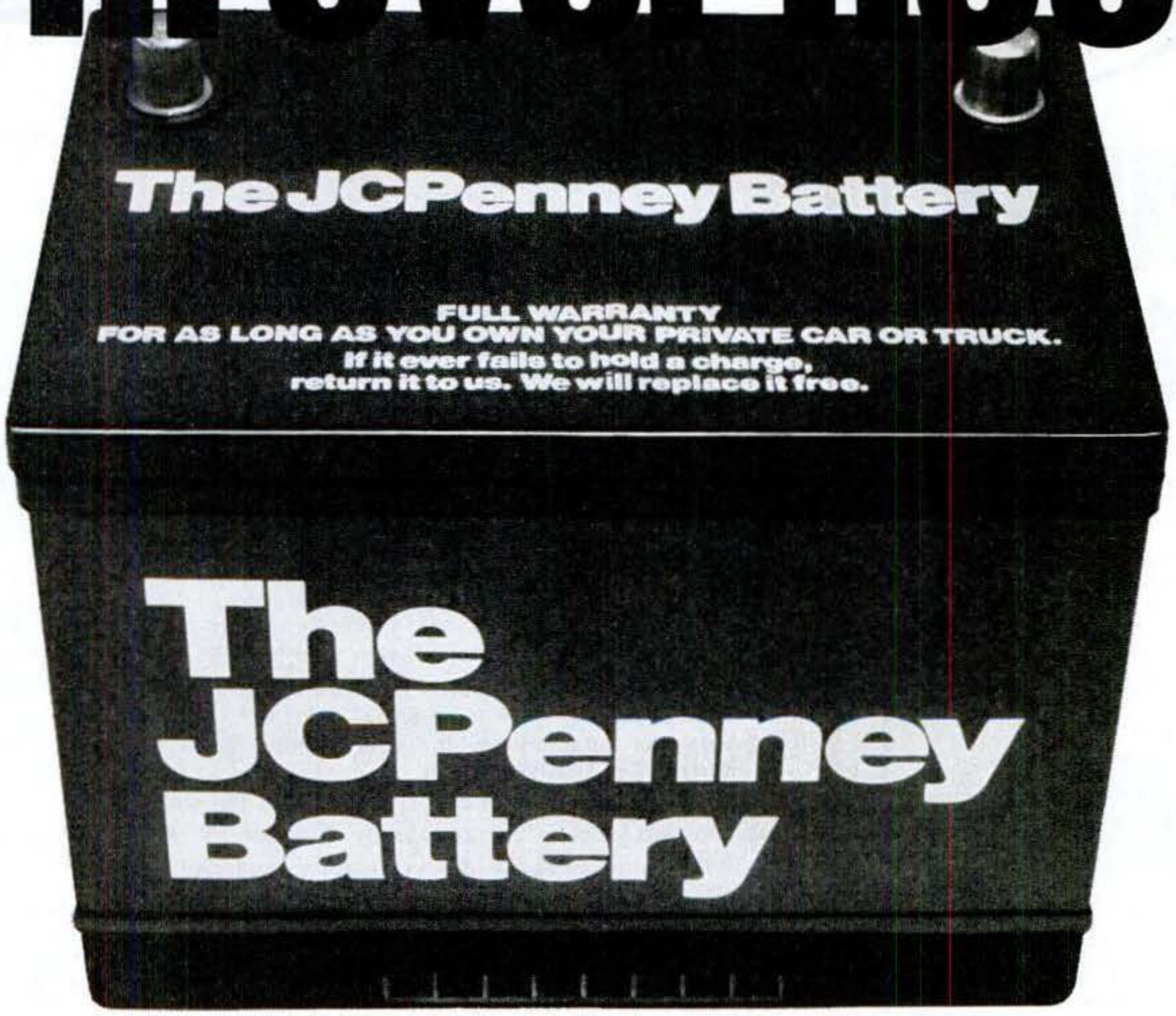

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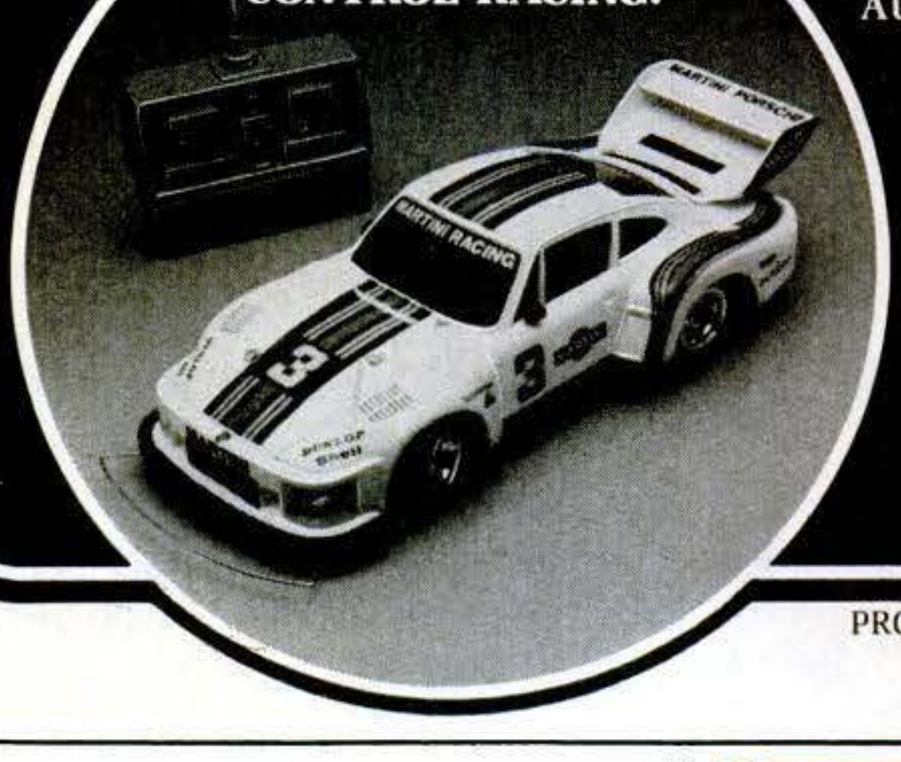

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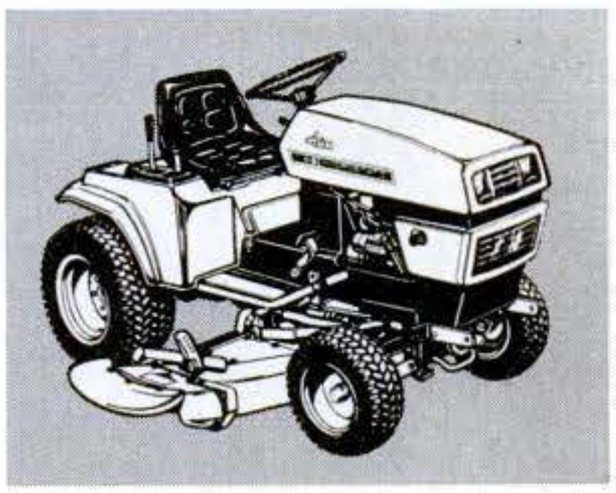

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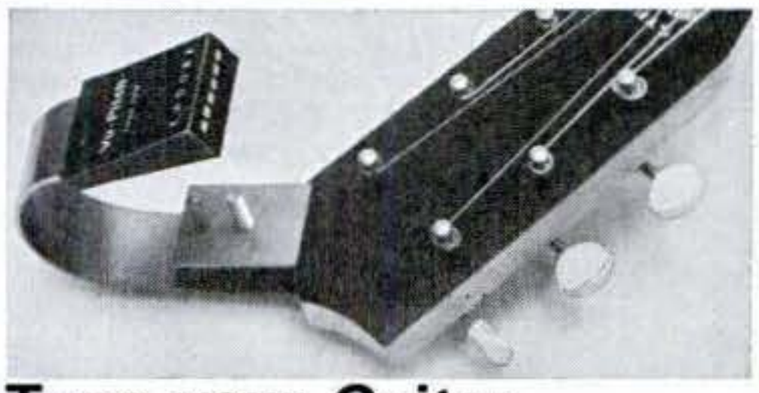

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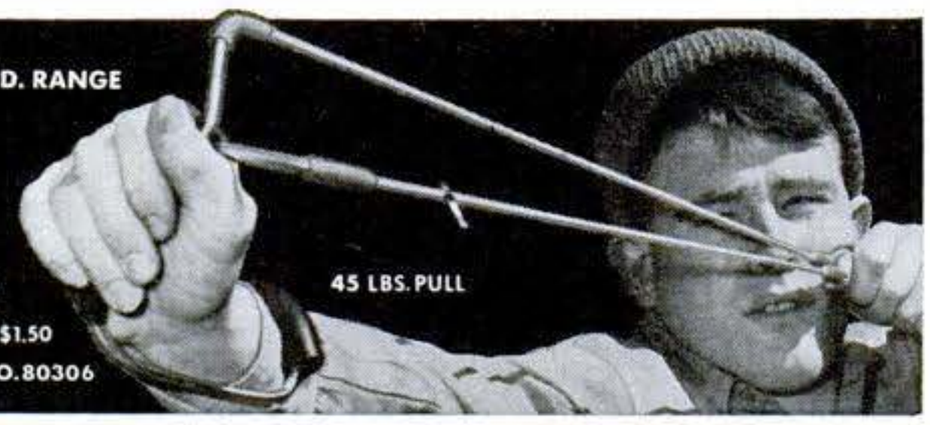

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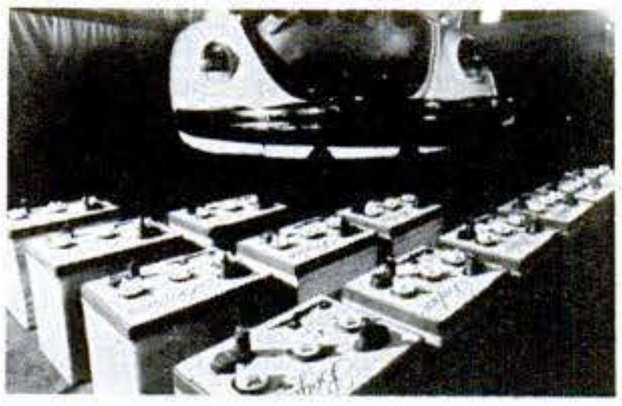

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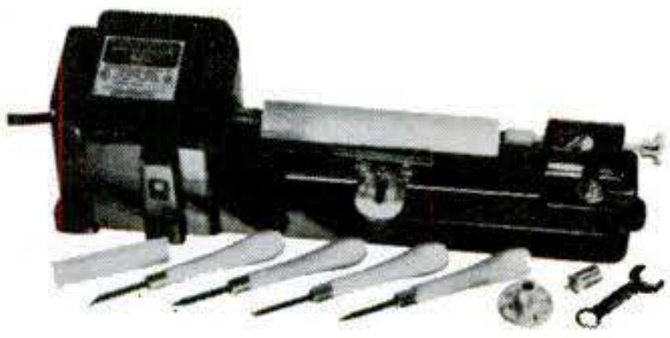

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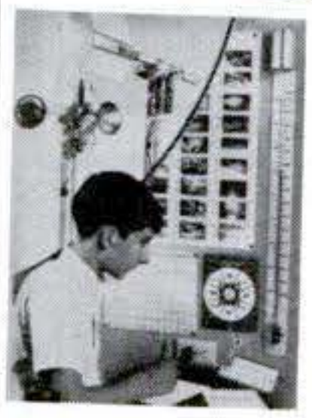

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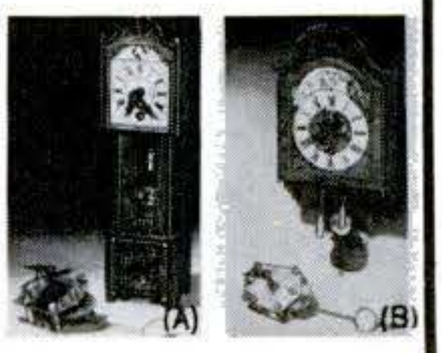

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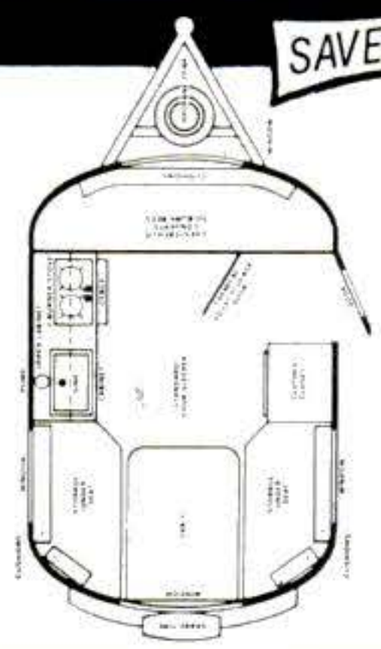

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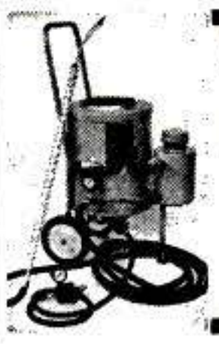

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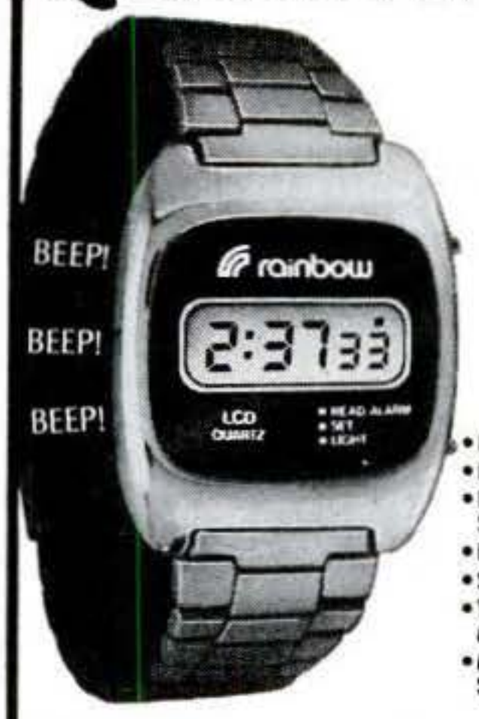

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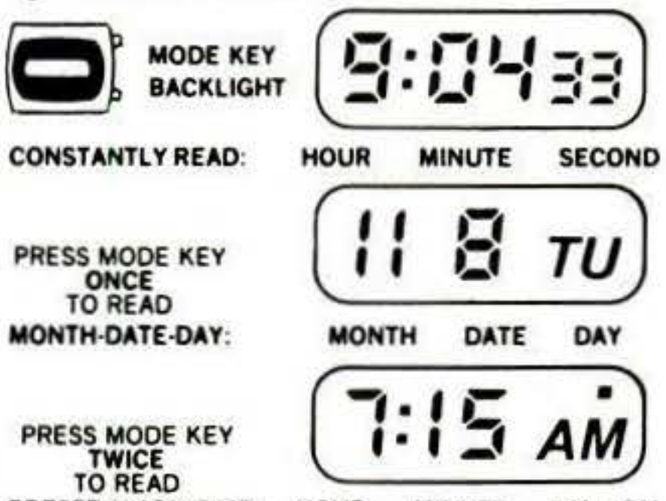

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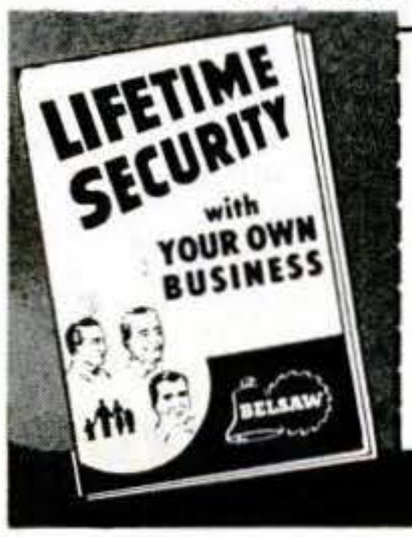

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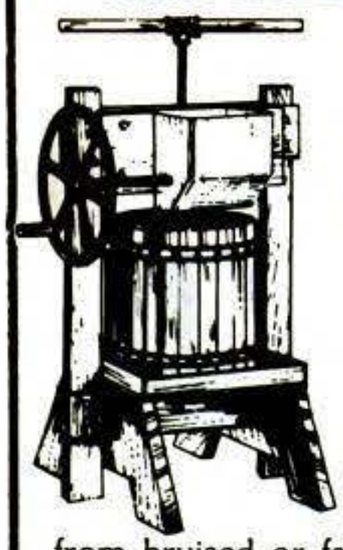

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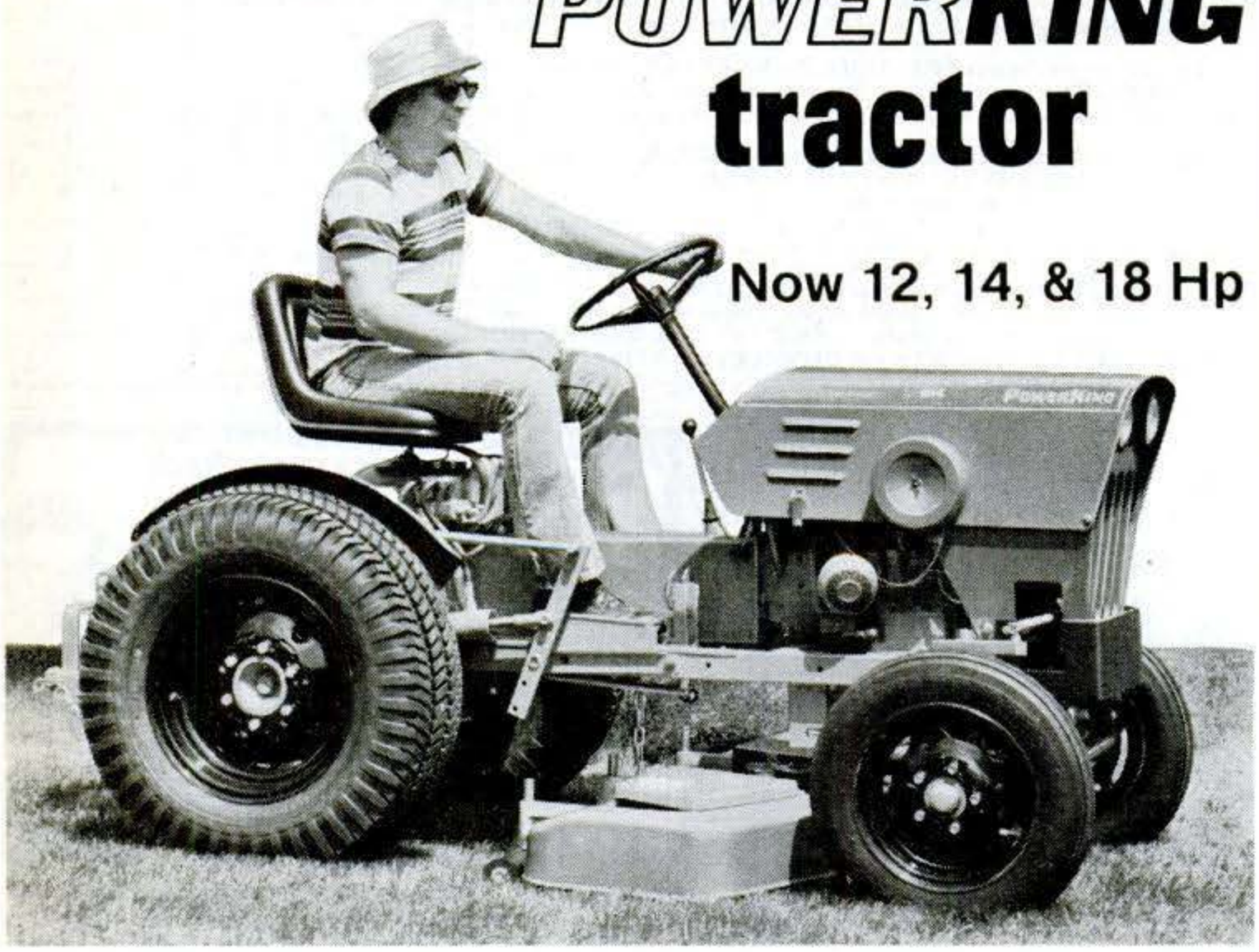

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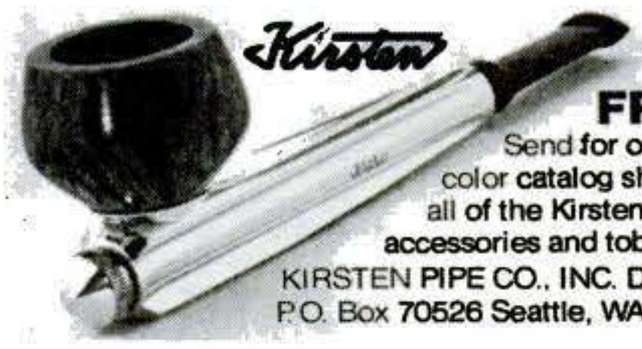

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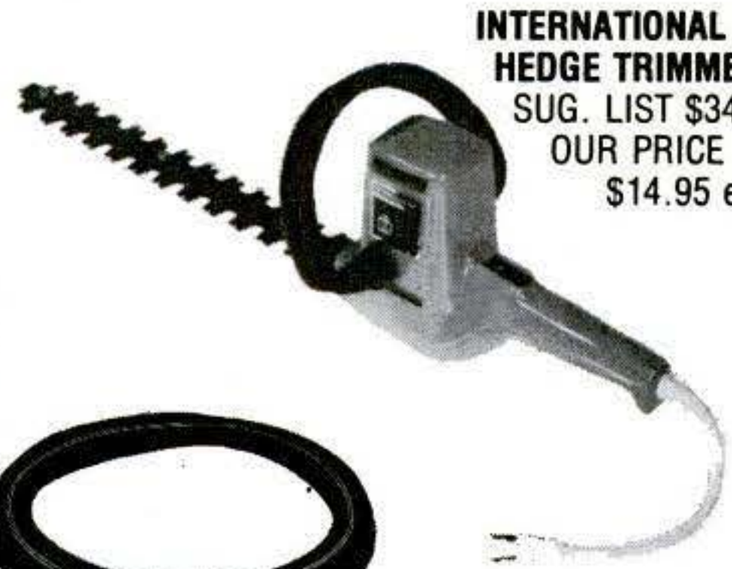

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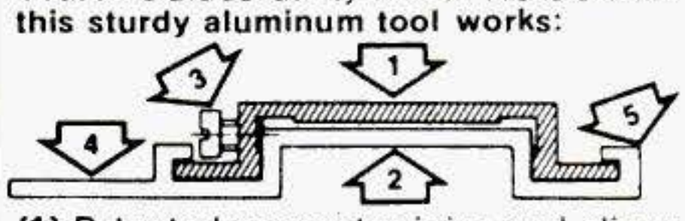

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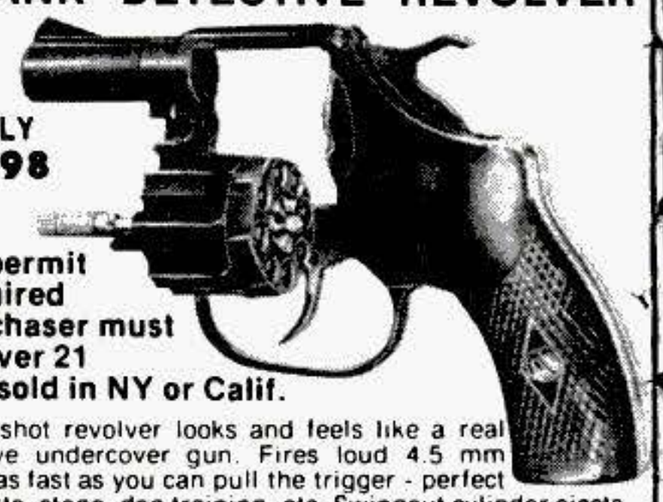

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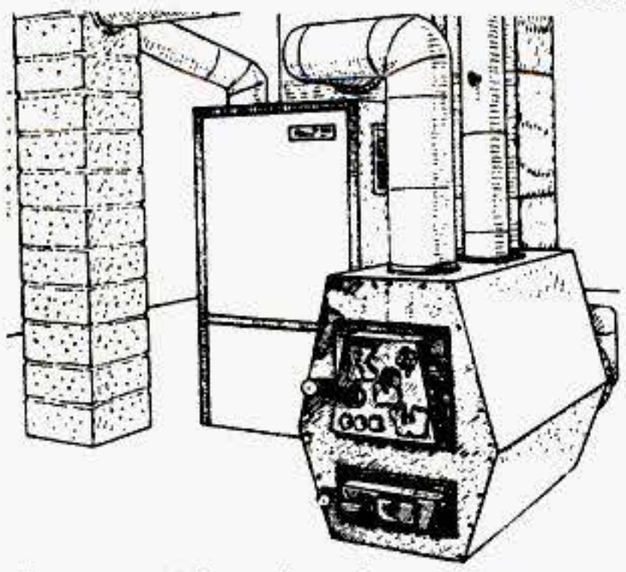

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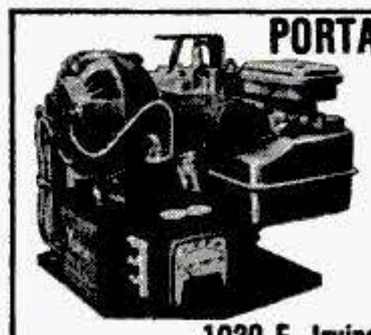

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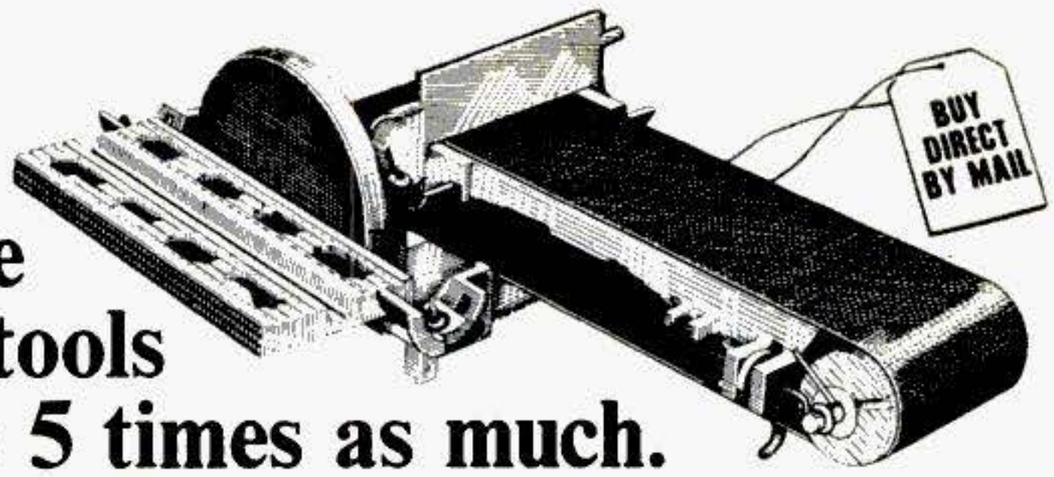

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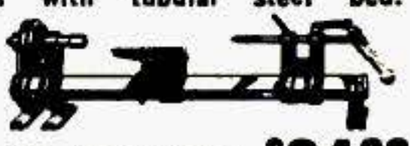

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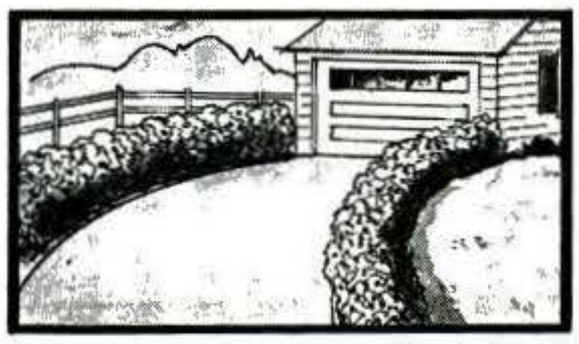
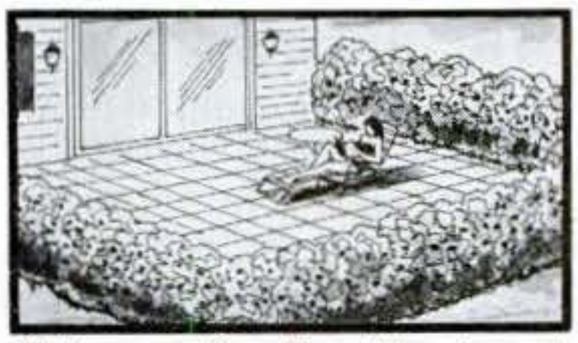
Grows Nearly High As A Man — Smothers itself with masses of glorious flowers and bushels of luscious fruit . . . from top to bottom! Enjoy first results IN JUST 90 DAYS! (once established, yields up to 1,200 cherries per season, by actual count).

NOW! PICK THOUSANDS OF CHERRIES WITHOUT PLANTING A TREE!



Line Your Driveway With Thousands of Cherry-Pie Fruits and Masses of Cherry-Blossom Blooms!



Circle your patio with a living fence of flowers and fruits . . . a spectacular show of beauty all spring, summer, fall — right up to frost!

Frame an entire side of your home or garage with eye-stopping beauty PLUS mouthwatering taste-treats . . . thanks to plant science wonder discovery — this wondrous FLOWERING CHERRY-HEDGE!

Incredible FLOWERING CHERRY-HEDGE erupts in a 5-foot-high Flowerwall of Bloom and Luscious Cherry-Pie Fruits — STARTING IN JUST 90 DAYS!

Sweeps forth like a flaming hedge of azaleas — and loads itself down with thousands of cherries from top to bottom!

THINK OF IT! BLOOMS BY THE THOUSANDS PLUS A WHOLE ORCHARD OF FRUIT FROM THIS ONE AMAZING HYBRID DISCOVERY!

Who says that for cherries by the bushel you have to nurse, baby and coax a tree for half a lifetime? Sure, it used to be that way — BUT NOT ANYMORE! Because this year . . . starting in 90 days — you are going to grow one of the most wondrous sights in all of nature . . . Yes, one of the most exciting breakthrough discoveries of our century . . . a fantastic flowering hedge that surges forth in a torrent of magnificent bloom . . . and then like magic, smothers itself top to bottom with armfuls and armfuls of the juiciest cherries you ever sunk a tooth into. Cherries so desperate to produce you'll actually pick as many as 30 to 40 pints of luscious fruit from each and every plant! Yes, actually pick your first fruit this very year . . . and huge bumper crops for years and years to come.

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Just think of the incredible beauty as you line your garden walls and walks . . . frame the side of your house . . . screen backyard fences . . . circle your patio . . . or literally 'bury' the side of your garage under man-high drifts of flowers . . . and then see this wondrous "flowering orchard" transform itself into a LIVING CHERRY FACTORY, so thickly clustered with big, juicy cherries the branches actually arch over from the sheer weight of the fruit.

ONE OF THE FASTEST, EASIEST-TO-GROW FRUITS EVER DISCOVERED — SUPER-HARDY TOO, DOWN TO 35-BELOW ZERO!

Best of all — unlike tree-grown cherries that demand years of tender care PLUS constant spraying, pruning, dusting, not to mention a ladder to pick them) — with this incredible FLOWERING CHERRY-HEDGE . . . even a 6-year old child can simply walk up and pick cherries by the bowlful right off the plant. Yes, the plumpest, juiciest cherries you ever tasted in your life. The kind you'd gladly pay up to 79¢ a pound for in fine food stores . . . (that is, if you can find them) . . . yours — up to 40 HEAPING BASKETS OF CHERRIES PER PLANT — for less than 5¢ a basket!

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SORRY, BUT OUR SUPPLY OF THIS HYBRID DISCOVERY IS LIMITED — THIS OFFER MAY NOT BE REPEATED THIS YEAR!

Now the price of this wondrous FLOWERING CHERRY-HEDGE is not the $10 or $15 you might expect (like slow-growing trees would cost you) — but a mere $4.95 for a complete 3-plant set, (enough for a solid 20-foot hedge of flowers and luscious fruit). Think of it! Only $4.95 for CHERRIES BY THE THOUSANDS UPON THOUSANDS WITHOUT PLANTING A TREE! And remember results guaranteed or money refunded (except postage and handling).

However, because our supplies of FLOWERING CHERRY-HEDGE are extremely limited . . . this offer may not be repeated this year. And since now is the time to plant this wonder of nature if you want to enjoy first results starting in JUST 90 DAYS — act immediately!

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Please rush me the number of FLOWERING CHERRY-HEDGE plants I have checked below. I understand they must erupt in the most lavish display of both flowers and fruit I have ever seen in my life, STARTING IN JUST 90 DAYS, or my money refunded (except postage & handling).

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11" Bandsaw

This is the only 11" bandsaw available that offers unlimited cut-off capacity on workpieces up to 3⅞" wide, thanks to our exclusive reversible blade guides that let you twist the blade to a 30° angle from the frame. Our patented self-aligning pulley design eliminates the need for continual tracking adjustments . . . and setting the blade tension is as simple as matching the indicator on the tension gauge with the width blade you are using. There's no guesswork!

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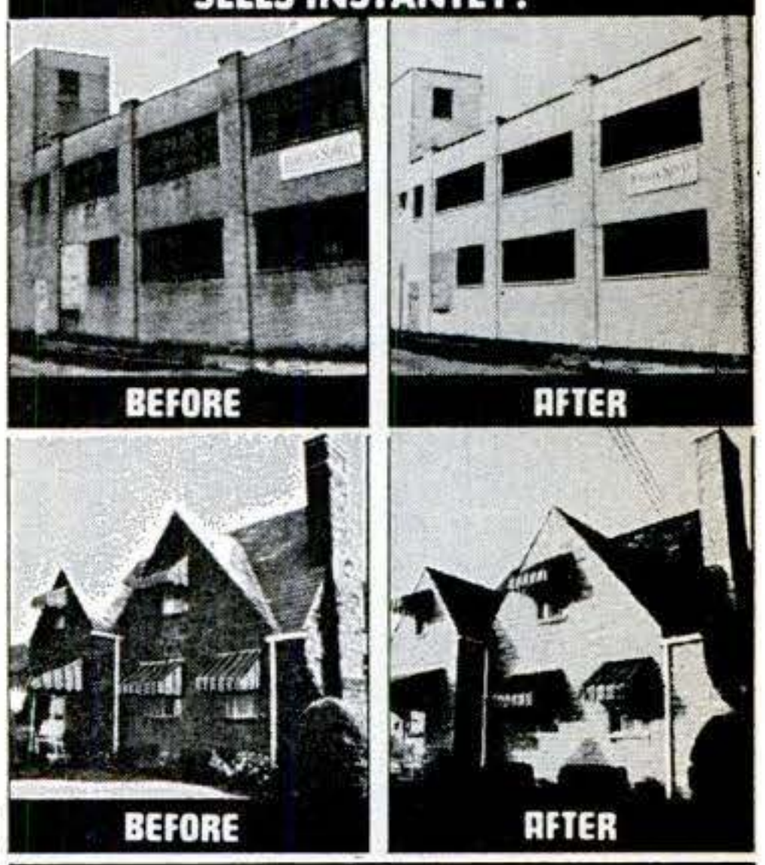

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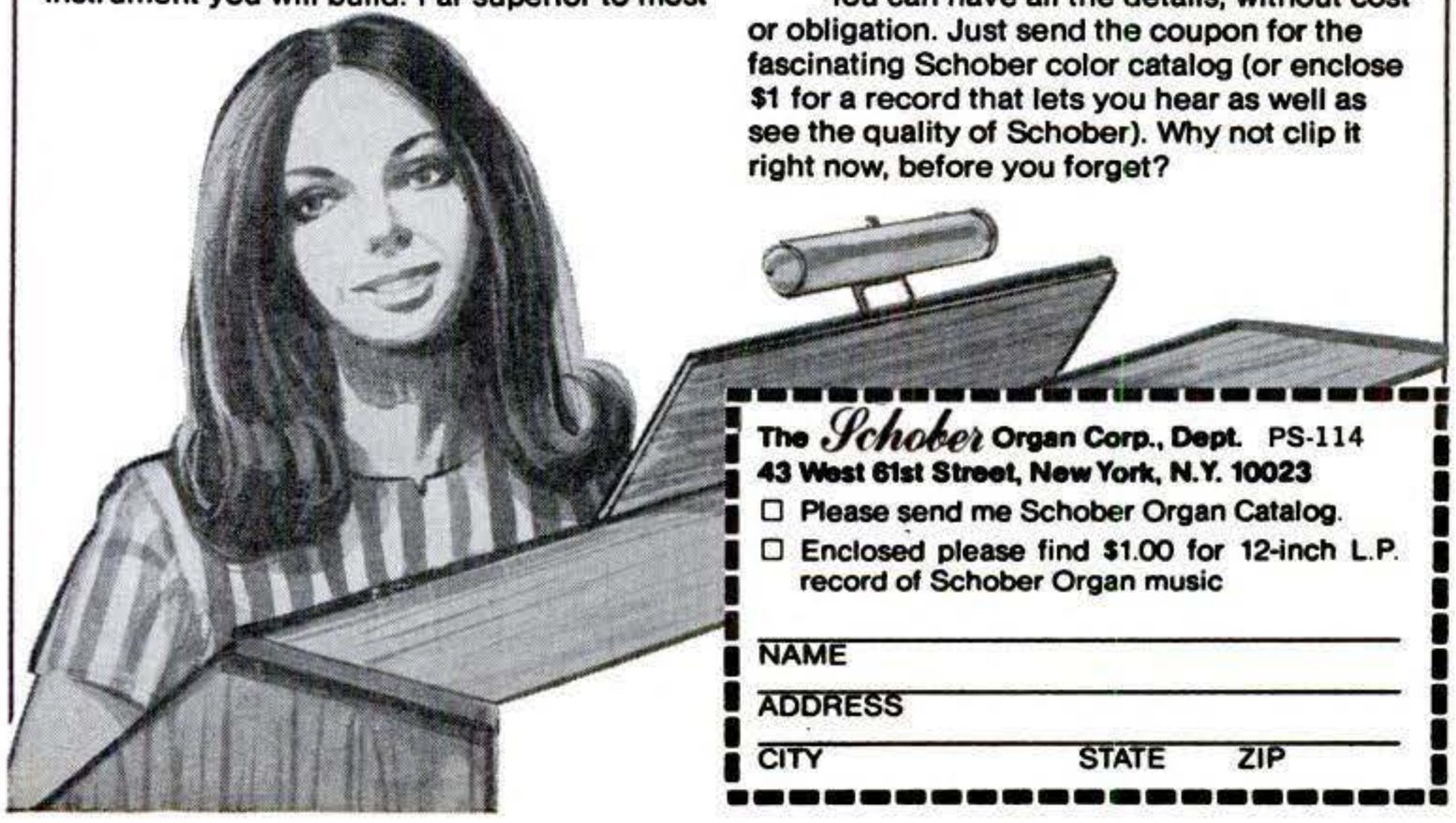

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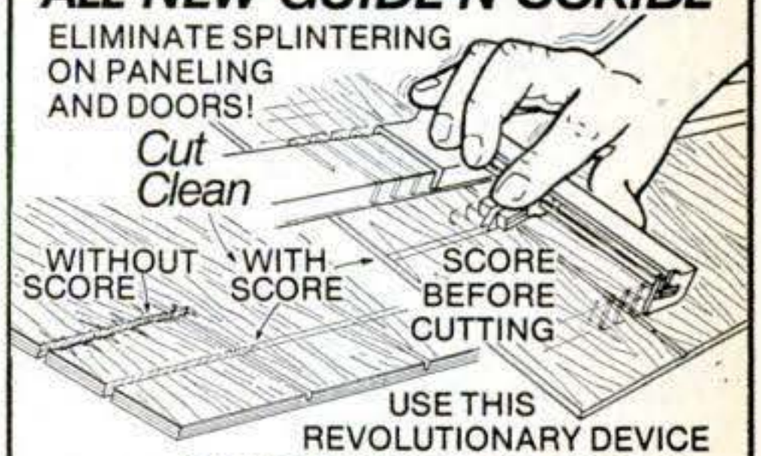

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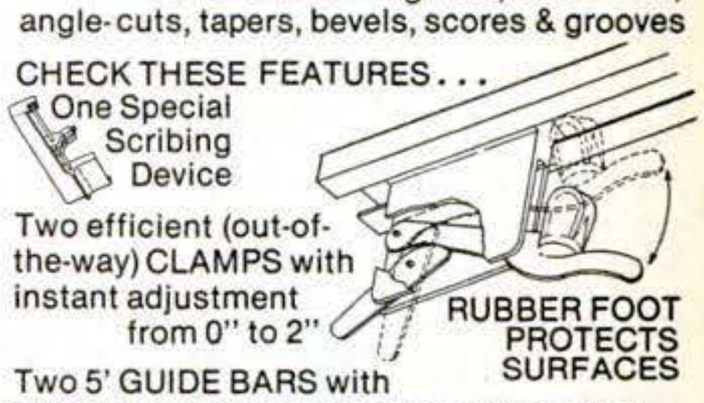

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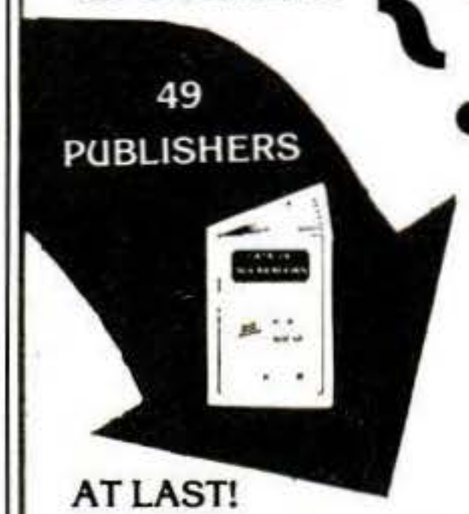

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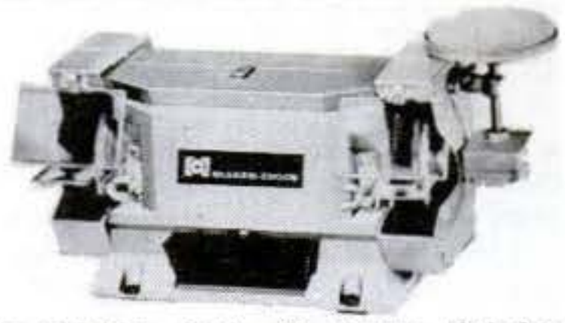

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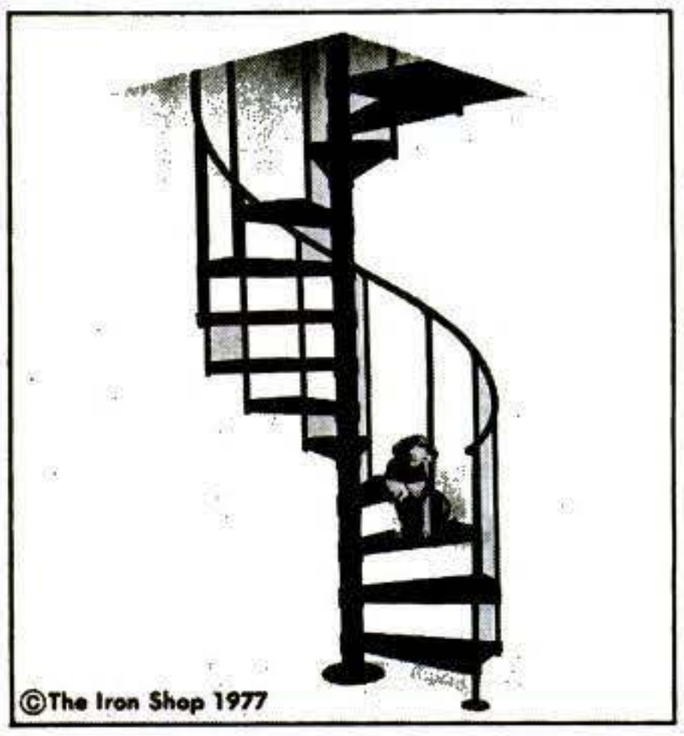

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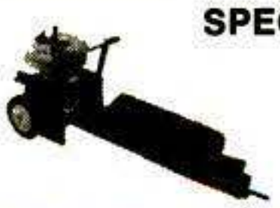

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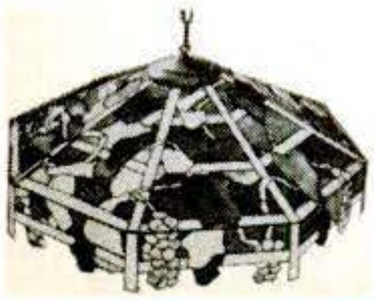

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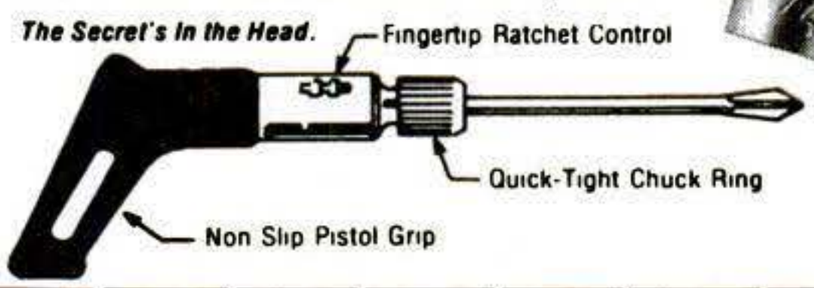

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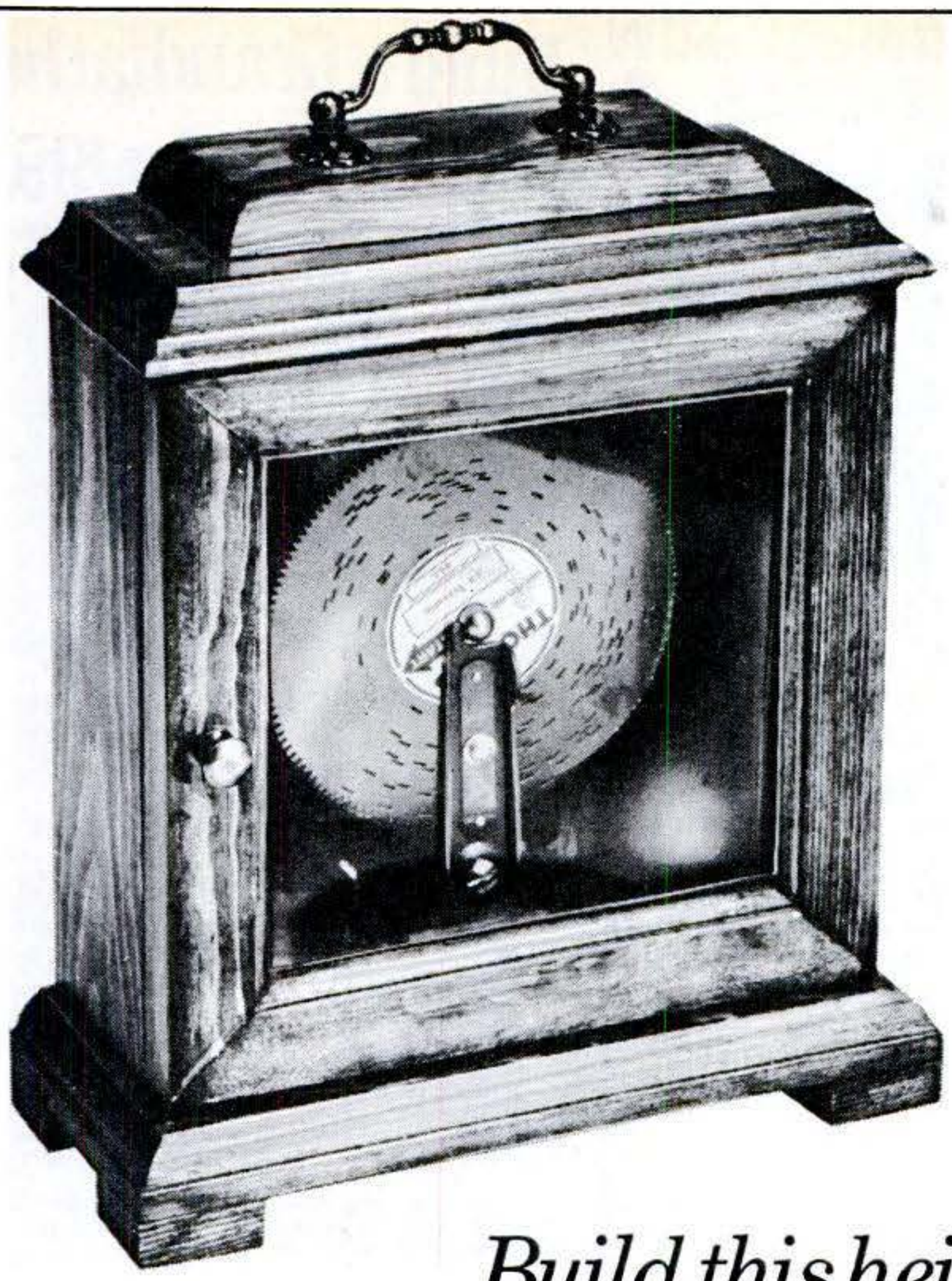

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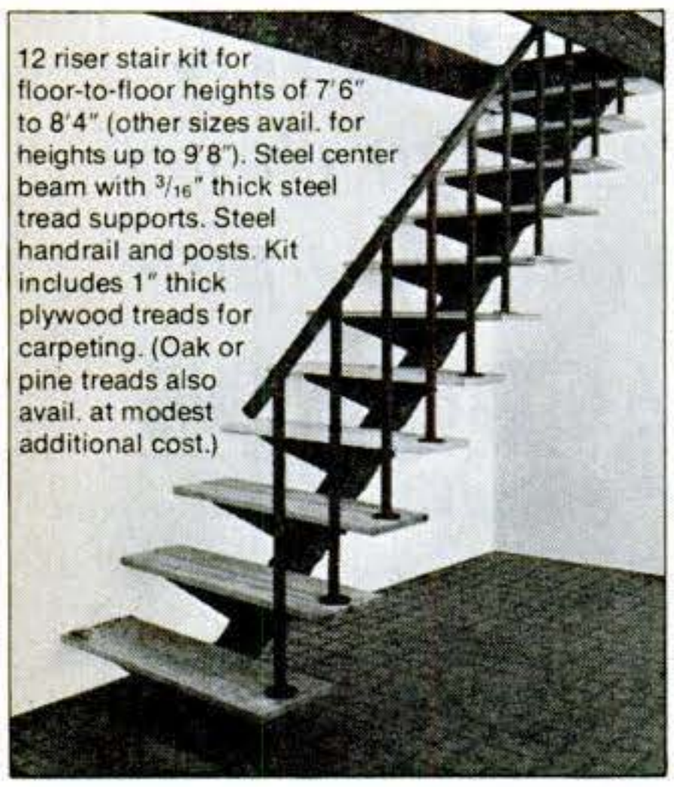

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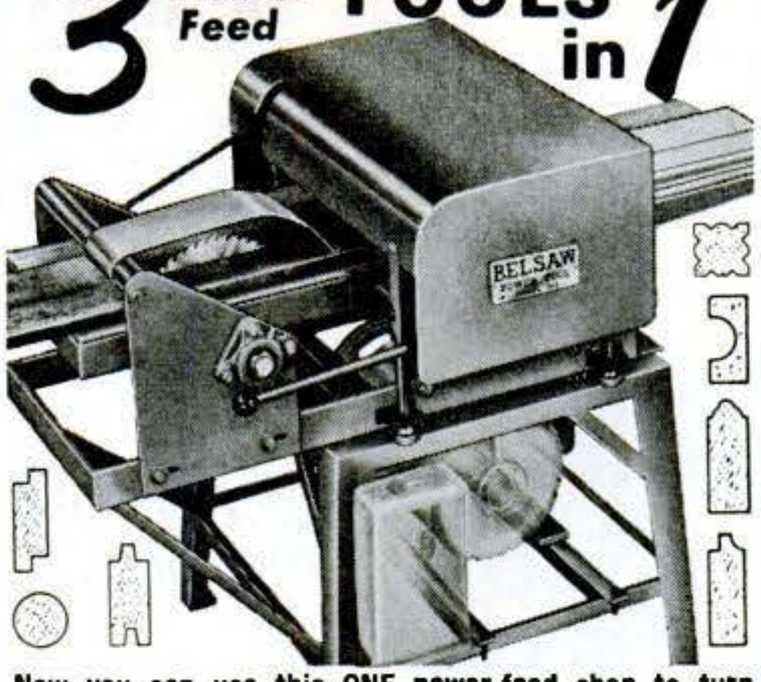

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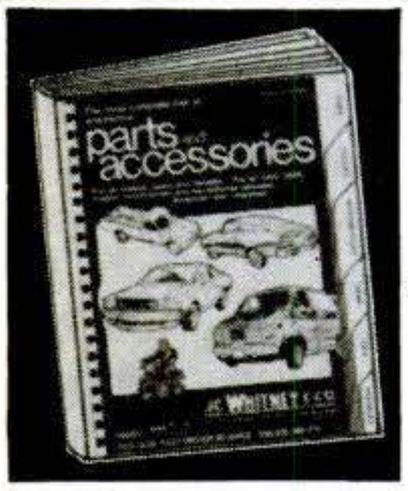

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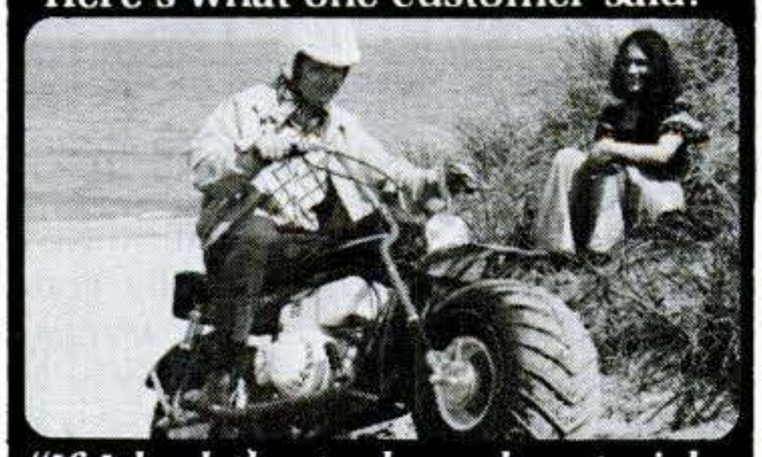

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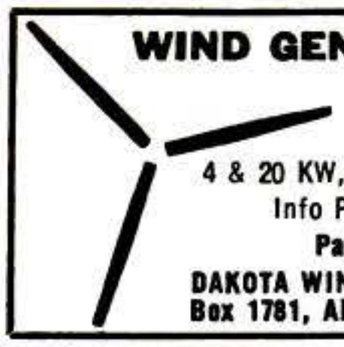

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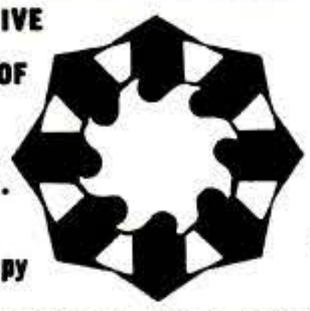

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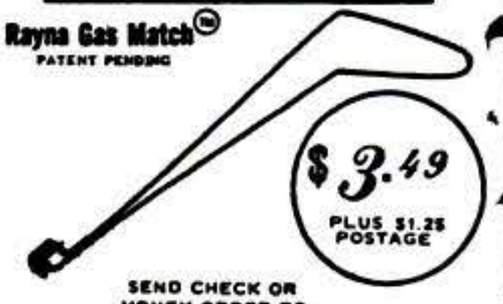

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SOLAR Heating differential thermostat, ½ hp Adjustable set points, manual-auto switch, Sensors included, $55.00. Thanor Enterprises, Inc., 817 West St., Wilmington, DE 19801.

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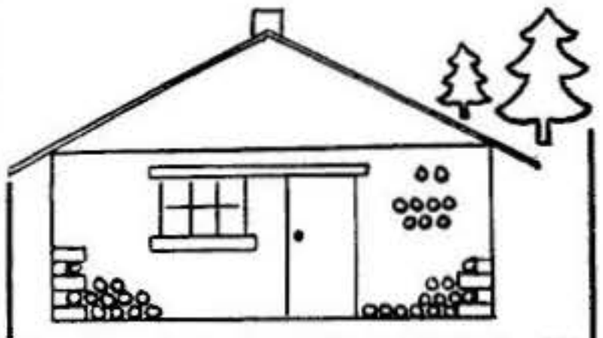

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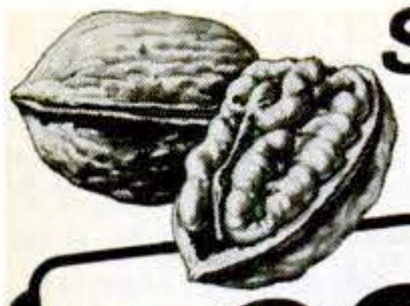

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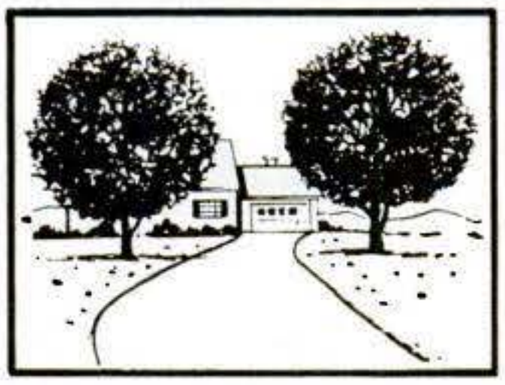

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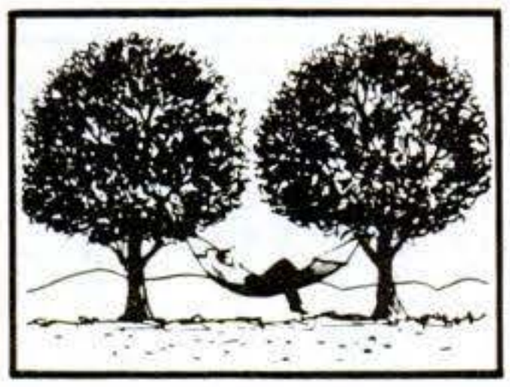

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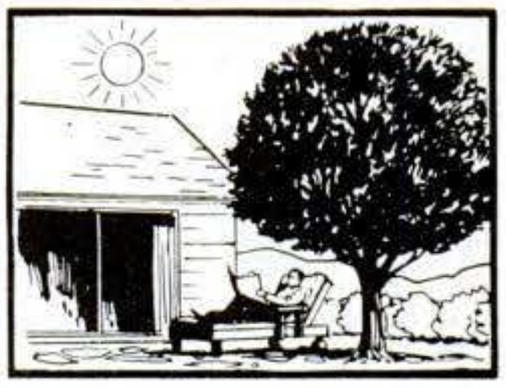

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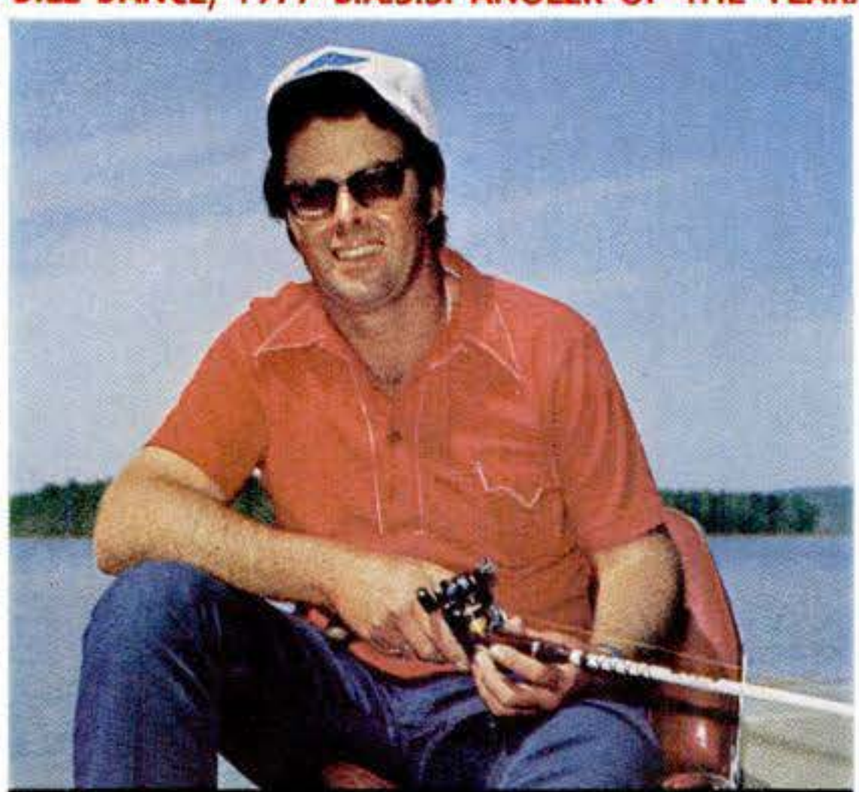

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